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LESSONS

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IN

GEOGRAPHY,

INCLUDING

MATHEMATICAL, PHYSICAL,

AND

POLITICAL GEOGRAPHY,

BY

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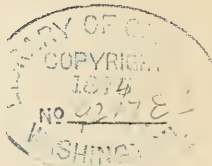
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DEFINITIONS

OF

TERMS USED IN MATHEMATICAL GEOGRAPHY.

The various things around us, of which we gain a knowledge by our senses, are *objects*, or forms of matter.

These objects all have length, breadth, and thickness, *i.e.* they extend in three directions.

Since objects have extension, they must have something in which to extend.

This *something* we call space.

SPACE.—Space is the possibility of extension; a necessary condition to the existence of matter.

SOLID.—A solid is a limited portion of space having extension in *three* directions.

MATERIAL SOLID.—A material solid is a limited portion of space filled with matter.

SURFACE.—A surface is limited extension in *two* directions.
The boundaries or limits of a solid are surfaces.

LINE.—A line is extension in *one* direction.

The boundaries or limits of a surface are lines.

POINT.—A point is simply location, *without* extension in *any* direction.

If we represent to the eye a point, a line, or a surface, we must use an object which has extension in three directions, i. e. a material solid. In these definitions we deal with space, extension, and locality, not with matter. The definitions are the definitions of mathematical or *pure* solids, surfaces, lines, and points, as distinguished from *material* solids, surfaces, lines, and points.

From the manner in which they are generated, a line, a surface, and a solid may be defined as follows:

A line is the *path* of a point moving in any direction.

A surface is the *path* of line moving in any direction other than that of its extent.

A solid is the *path* of a surface moving in any direction other than that of its extent.

Classifying surfaces as to their direction, we have:

1. PLANE SURFACE.—A plane surface is a surface whose direction does not change in any portion of its extent.

2. CURVED SURFACE.—A curved surface is a surface whose direction is continually changing in one or both of the directions of its extent.

PLANE.—A plane is unlimited, unvarying extension in two directions.

A plane surface may be called a limited portion of a plane.

Classifying lines as to their direction, we have:

1. STRAIGHT LINES.—A straight line is a line whose direction does not change.

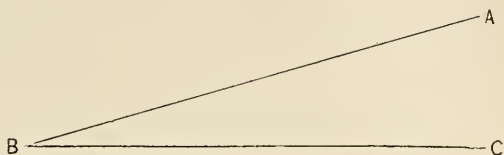
When lines are spoken of, straight lines are meant, unless otherwise distinguished.

2. **CURVED LINES.**—A curved line is a line whose direction is continually changing.

Classifying lines as to their relative direction we have:

1. **PARALLEL LINES.**—Parallel lines are lines extending in the same direction, at every point equi-distant from each other.

AN ANGLE.—An angle is the difference in direction of two lines, surfaces, or planes, which meet or tend to meet.



ABC represents an angle. AB and BC are the sides of the angle, and B is its vertex.

2. **PERPENDICULAR LINES.**—Two lines are perpendicular to each other when they meet, or tend to meet, in such a manner as to form *equal* angles.

3. **OBLIQUE LINES.**—Two lines are oblique to each other when they meet, or tend to meet, in such a manner as to make *unequal* angles.

VERTICAL LINES.—Vertical lines are lines extending through the centre of the earth.

HORIZONTAL LINES.—Horizontal lines are lines which are perpendicular to vertical lines.

Surfaces and planes may be parallel, perpendicular, or oblique to each other.

A RIGHT ANGLE.—A right angle is the difference in direction of two lines, surfaces, or planes, which are perpendicular to each other.

AN OBLIQUE ANGLE.—An oblique angle is the difference in direction of two lines, surfaces, or planes, which are oblique to each other.

AN ACUTE ANGLE.—An acute angle is an oblique angle which is less than a right angle.

AN OBTUSE ANGLE.—An obtuse angle is an oblique angle which is greater than a right angle.

Angles may be classified as follows:

$$\text{Angles.} \left\{ \begin{array}{l} \text{Right angles.} \\ \text{Oblique angles.} \end{array} \right. \left\{ \begin{array}{l} \text{Acute.} \\ \text{Obtuse.} \end{array} \right.$$

A CIRCLE.—A circle is a plane surface bounded by a curved line, such that all points in that line are equally distant from a point within, called the centre.

THE CIRCUMFERENCE OF A CIRCLE.—The circumference of a circle is the line which bounds it.

A DIAMETER OF A CIRCLE.—A diameter of a circle is a line passing through its centre and terminating in the circumference.

A circle may have an infinite number of diameters.

A RADIUS OF A CIRCLE.—A radius of a circle is a line extending from the centre of a circle to any point in its circumference.

A circle may have an infinite number of radii.

GENERATION OF THE CIRCLE.—If a line, as A———B, be revolved about the point A, it will describe a circle. A will represent the centre of the circle, and AB the radius. The line described by B represents the circumference of the circle.

AN ARC OF A CIRCUMFERENCE.—An arc of a circumference is any part of it.

DIVISIONS OF A CIRCUMFERENCE.—A circumference is divided into 360 equal parts, called degrees, marked thus, ($^{\circ}$). A degree into 60 equal parts, called minutes, marked thus, ($'$). A minute into 60 equal parts, called seconds, marked thus, ($''$). Five degrees, twenty-four minutes, and six seconds, are marked thus, ($5^{\circ} 24' 6''$).

MEASUREMENT OF ANGLES.—An angle is measured by the number of degrees of a circumference included between its sides. The centre about which the circumference is drawn, must be the vertex of the angle.

MEASUREMENT OF A RIGHT ANGLE —A right angle includes between its sides, and is measured by, 90° of a circumference.

MEASUREMENT OF OBLIQUE ANGLES.—An *acute angle* includes between its sides, and is measured by, less than 90° . An *obtuse angle* includes between its sides, and is measured by, more than 90° of a circumference.

A SPHERE.—A sphere is a solid bounded by a curved surface, such that all points in that surface are equi-distant from a point within, called the centre.

GENERATION OF THE SPHERE.— If a circle be revolved about one of its diameters, it will describe a sphere; and the circumference of the circle will describe the surface of the sphere.

A diameter of a sphere is a line passing through its centre and terminating at both ends in its surface. A radius of a sphere is a line extending from its centre to any point in its surface.

CIRCLES OF A SPHERE.—Every section of a sphere made by a plane is a circle. If the plane pass through the centre of the sphere, the section is a *great circle*. If it does not pass through the centre, the section is a small circle.

A ZONE.—A zone is that part of the surface of a sphere included between two parallel circles.

AN ELLIPSE.—An ellipse is a plane surface bounded by a curved line, such that the sum of the distances from any point in that line, to two fixed points within is invariable. The fixed points are called the *foci* of the ellipse.

The diameters of an ellipse are unequal.

MECHANICAL GENERATION OF THE ELLIPSE.—Fasten two tacks in a board; take a string three or four times as long as the distance between the tacks; tie the ends of the string together and throw it over the tacks; draw the string tight with a pencil, and move the pencil around the tacks, keeping the string tight, and the pencil will trace the boundary of an ellipse.

AN OBLATE SPHEROID.—An oblate spheroid is a solid, in form like a sphere flattened at opposite sides.

GENERATION OF THE OBLATE SPHEROID.—If an ellipse be revolved about its shortest diameter it will describe an oblate spheroid. Our earth is an oblate spheroid.

THE SOLAR SYSTEM.

THE SUN.—The sun is an immense sphere of fluid, molten matter, surrounded by an intensely heated atmosphere.

There are around the sun a large number of dark, cold bodies, which receive light and heat from the sun.

THE PLANETS.—Nine of these dark, cold bodies are much larger than the others, and are called *Planets*.

THE ASTEROIDS.—At present there are known to be 134 others, much smaller than the planets, which are called *Asteroids*.

NAMES IN ORDER FROM THE SUN.—The names of these bodies in order from the sun, are Vulcan, Mercury, Venus, Earth, Mars, Asteroids, Jupiter, Saturn, Uranus, and Neptune.

RELATIVE SIZE.—Among the planets, our earth is fourth in order from the sun, and fifth in size; Vulcan, Mercury, Mars, and Venus being smaller; Neptune, Uranus, Saturn, and Jupiter being larger.

MOONS.—Around some of the planets, smaller bodies called *moons* revolve. Earth has one, Jupiter four, Saturn eight, Uranus six, and Neptune two.

FORM AND MOTIONS.—The sun, planets, asteroids, and moons, have each a spherical form, and each rotates on an axis.

The planets and asteroids revolve around the sun in elliptical orbits.

ATTRACTION.—Attraction is that force by which all bodies tend toward each other, and toward a common centre.

Attraction *varies*: 1. directly as the weight or mass of the bodies between which it acts; 2. inversely as the square of the distance of the bodies between which it acts.

A CONSTANT FORCE.—A constant force is one that acts continuously. Attraction is a constant force.

AN IMPULSIVE FORCE.—An impulsive force is one which acts for a time, and then ceases to act; as, a ball thrown from a gun, moves by an impulsive force.

CURVILINEAR MOTION.—Curvilinear motion, or motion in a curved line, is caused by two unequal constant forces acting in different directions, or by a constant and an impulsive force acting in different directions.

The motion of the planets about the sun is motion in a curved line, caused by two forces acting in different directions. *Attraction* is one of these forces.

COMETS.—Comets are light, gaseous, or nebulous bodies, which revolve around the sun in elliptical orbits much more elongated than those of the planets.

The sun, planets, asteroids, moons, and comets, together constitute the *solar system*.

MATHEMATICAL GEOGRAPHY.

FORM OF THE EARTH.—The earth *appears* to be flat, but its *real* form is that of an oblate spheroid. This has been proved by actual measurement, and by experiments with the pendulum.

That the earth is spherical is shown in various ways:

1. When the earth comes between the sun and the moon it casts a shadow on the moon, causing an eclipse. This shadow is always circular; and since a sphere is the only body that under all circumstances casts a circular shadow, we infer that the earth is spherical.

2. THE SENSIBLE HORIZON.—The sensible horizon is the line where the earth and sky seem to meet.

When our view is unobstructed, this line is everywhere equidistant from us; it is the circumference of a circle. Our view enlarges equally in all directions as we ascend from any point on the surface of the earth. This could not be true if the earth were not spherical in form.

Several other proofs are sometimes given; as, the circumnavigation of the earth, the appearance of ships leaving and coming into port, the elevation and depression of stars as we go north or south, etc.

SIZE OF THE EARTH.—

The long diameter is 7925.604 miles.

The short diameter is 7899.114 miles.

The long circumference is 24899.022 miles.

The short circumference is 24857.5 miles.

MOTIONS.—First, *rotation*; second, *revolution*.

ROTATION.—The earth rotates on its shortest diameter.

THE AXIS.—The axis of the earth is the diameter upon which it rotates.

FIXED DIRECTIONS.—1. The direction *toward* which the earth rotates is *East*; the direction *from* which it rotates is *West*.

2. The direction of the axis is at right angles to the direction of motion, and is *North* and *South*.

PROOF OF ROTATION AND DIRECTION OF ROTATION.—If the earth rotates, the top of a tower moves faster than its base, and a ball dropped from the top would vary from a vertical line in the direction of the motion. A ball dropped from a tower on the earth varies, in falling, from a vertical line. The direction in which it varies is the direction of rotation, and is called *East*.

THE POLES.—The poles are the ends of the axis; one end is the *North Pole*, the other the *South Pole*.

If you face the east, the north pole is at your left, the south pole at your right.

The *North Star* is almost directly over the north pole, and when it can be seen, is frequently used as a point of reference in finding the fixed directions.

THE SOLAR DAY.—The average time in which the earth makes one rotation with reference to the sun, is called the *solar day*.

The day is divided into 24 hours, the hour into 60 minutes, the minute into 60 seconds.

THE SIDEREAL DAY.—The time in which the earth makes one rotation with reference to some fixed star, is called a *sidereal day*.

It is 23 hours 56 minutes 4.1 seconds in length. It does not vary.

DAY AND NIGHT.—As the earth is a spherical body, only one-half of its surface can be lighted by the sun at one time.

At any place, that portion of the time of one rotation during which it is in the light, is called *day*; and the time during which it is in darkness is called *night*.

THE DAY CIRCLE.—The line which divides the light from the darkness is the circumference of a circle, called the *day-circle*. Owing to the motion of the earth from *west* to *east*, this line seems to move from *east* to *west*. Owing to the motion of the earth from *west* to *east*, the sun *seems* to move from *east* to *west*.

LOCATION OF PLACES.—To locate places, we must have:

1. Fixed directions;
2. A fixed unit of measurement;
3. Fixed lines from which to measure.

The fixed directions, North, South, East, and West, have already been determined.

For the purpose of obtaining fixed lines from which to measure, the fixed unit of measurement, and other lines to aid in locating places, the earth is considered as divided by certain circles, each having a fixed relation to the axis.

THE EQUATOR.—The equator is a great circle passing through the earth, midway between the poles, and perpendicular to the axis. It divides the earth into the *Northern* and the *Southern Hemispheres*.

The circumference of the equator is the long circumference of the earth; its length and form depend on the size and form of the earth.

This circumference is the *fixed line* from which to measure distance *north* or *south*.

A degree of this circumference is the *fixed unit of measurement*.

This degree is 60 geographical, or 69.164 statute miles in length.

MERIDIANS.—The meridians are half great circles passing through the earth from pole to pole, perpendicular to the equator. Every place on the earth has its meridian.

The curved boundary of any meridian *may* be used as a fixed line from which to measure distance *east* or *west*.

By common consent the curved boundary of the meridian of Greenwich, near London, *is used* as the line from which to measure distance east or west.

Some nations use the boundary of the meridian of their capital as a fixed line from which to measure; as do France, Russia, United States etc.

The boundaries of meridians are represented on maps and globes, by lines extending from pole to pole.

The meridian of Greenwich is called the *prime meridian*, and is marked thus, (o). Meridians corresponding to each degree of the circumference of the equator, are numbered east and west from this meridian, from 1 to 180. The meridian 180 east, and the meridian 180 west coincide, and, together with the prime meridian, form a *meridian circle*. The 20th meridian west and the 160th meridian east, together form a meridian circle which divides the earth into the *Eastern* and the *Western Hemispheres*.

PARALLELS.—The parallels are small circles passing through the earth parallel to the equator, and perpendicular to the axis.

The circumferences of the equator and parallels are represented on maps and globes, by lines extending east and west perpendicular to the lines which represent the boundaries of the meridians.

The equator is sometimes called the *prime parallel*, and is marked thus, (o). Parallels corresponding to each degree in the boundary of a meridian, are numbered from 1 to 89, north and south of the equator. The parallels decrease in size toward the poles, so that 90 north and south are not parallels, but points, which coincide with the poles.

LATITUDE.—Latitude is distance north or south of the equator, measured in degrees, minutes, and seconds of the circumferences of meridian circles.

As the meridian circles are not exact circles, but ellipses, owing to the oblateness of the earth, these degrees vary slightly in length.

The 1st degree N. or S. of the equator is 68.698 miles.

The 45th degree N. or S. of the equator is 69.046 miles.

The 89th degree N. or S. of the equator is 69.396 miles.

The latitude of a place is its distance north or south of the equator, measured in degrees, minutes, and seconds; as,

Washington is in N. Lat. $38^{\circ} 53' 39''$.

Rio Janeiro is in S. Lat. $22^{\circ} 54' 42''$.

LONGITUDE.—Longitude is the distance east or west of the prime meridian, measured in degrees, minutes, and seconds of the circumferences of the equator and parallels.

As the parallels decrease in *size* toward the poles, the degrees of longitude decrease in *length* toward the poles.

A degree of longitude on the equator is 69.164 miles.

A degree of longitude on the 45th parallel is 48.982 miles.

A degree of longitude on the 89th parallel is 1.211 miles.

The longitude of a place is its distance east or west of the prime meridian, measured in degrees, minutes, and seconds; as,

New York is in W. Lon. $74^{\circ} 0' 3''$.

Rome is in E. Lon. $12^{\circ} 27' 14''$.

PROBLEMS IN LATITUDE AND LONGITUDE.

Mention two meridians that together form a meridian circle.

NOTE.—Any two meridians that are 180° apart, together form a meridian circle.

What places have no latitude?

What places have the greatest latitude?

What places have no longitude?

What places have the greatest longitude?

What is the difference between 14° and 40° N. Lat.?

What is the difference between 25° N. Lat. and 15° S. Lat.?

What is the difference between 18° E. Lon. and 22° W. Lon.?

Mention three cities on each continent that are in nearly the same Longitude as Columbus, Ohio.

Mention three cities that are in nearly the same Longitude as New Orleans.

What island in about 50° N. Lat. and 125° W. Lon.?

What island in about 80° N. Lat., and 20° E. Lon.?

What island in 40° S. Lat., and 173° E. Lon.?

The mouth of what river is in $35^\circ 40'$ S. Lat., and $55^\circ 10'$ Lon.?

What island in 0° Lat., and 100° E. Lon.?

The mouth of what river in 0° Lat., and 50° W. Lon.?

What city in 0° Lon., and about 52° N. Lat.?

What gulf in 0° Lat., and 0° Lon.?

Give the Latitude and Longitude of the mouth of the Columbia River.

Give the Latitude and Longitude of Lima, South America.

Give the Latitude and Longitude of Constantinople.

Give the Latitude and Longitude of Sydney, Australia.

The teacher should give numerous problems similar to those above given.

REVOLUTION.—The earth revolves around the sun in an elliptical path or orbit.

THE ECLIPTIC.—The ecliptic is the plane in which the earth's orbit lies.

THE YEAR.—The year is the time of one revolution of the earth around the sun. It is 365 days, 5 hours, 48 min., and 48 sec. in length.

NOTE.—The earth moves faster in some portions of its orbit than in others, which is a reason for the varying length of the solar days.

INCLINATION OF THE AXIS.—The axis of the earth is inclined from a perpendicular to the ecliptic, at an angle of $23^{\circ} 27'$.

The axis is at all times inclined in the same direction, hence, the earth in its journey around the sun, receives the sun's rays perpendicularly on different portions of its surface, at different times in the year.

On the 20th of March, the sun's rays fall perpendicularly on the equator, and since one-half of the earth is lighted at one time, the sun's rays must fall obliquely on all places within 90° of this line; *i. e.* upon all places between the equator and the poles.

On the 21st of June, the axis is inclined toward the sun, and the sun's rays fall perpendicularly on a line $23^{\circ} 27'$ north of the equator, and obliquely on all places within 90° of this line; *i. e.* as far as $23^{\circ} 27'$ beyond the N. pole, and within $23^{\circ} 27'$ of the S. pole.

On the 22d of September, the sun's rays again fall perpendicularly upon the equator, and obliquely on places north and south of the equator, as on March 20th.

On the 21st of December, the axis is inclined from the sun, and the sun's rays fall perpendicularly on a line $23^{\circ} 27'$ south of the equator, and obliquely on all places within 90° each way from this line, *i. e.* as far as $23^{\circ} 27'$ beyond the S. pole, and within $23^{\circ} 27'$ of the N. pole.

THE TROPICS.—The tropics are parallels; one, called the Tropic of Cancer, is $23^{\circ} 27'$ north of the equator; the other, called the Tropic of Capricorn, is $23^{\circ} 27'$ south of the equator. The boundaries of the tropics mark the greatest distance, north and south of the equator, at which the sun's rays fall perpendicularly upon the earth.

THE POLAR CIRCLES.—The polar circles are parallels; one, called the Arctic Circle, is $66^{\circ} 33'$ north of the equator, and $23^{\circ} 27'$ from the north pole; the other, called the Antarctic Circle, is $66^{\circ} 33'$ south of the equator, and $23^{\circ} 27'$ from the south pole. The boundaries of these circles mark the greatest distance to which the sun's rays ever reach beyond, or recede from, the poles.

ZONES.—The equator, the tropics, and the polar circles divide the earth into belts, or zones, which, owing to their position, receive different amounts of heat during the year.

TORRID ZONES.—That belt between the tropics, $46^{\circ} 54'$ wide, receives the sun's rays perpendicularly, is much hotter than the others, and is called the *torrid region*. That part north of the equator is the *North Torrid Zone*, and that part south of the equator is the *South Torrid Zone*.

TEMPERATE ZONES.—On those belts lying between the tropics and the polar circles, the sun's rays always fall obliquely, hence, they are not as warm as the torrid zones, and are called the *temperate zones*.

The one between the tropic of Cancer and the Arctic circle is the *North Temperate Zone*; the one between the tropic of Capricorn and the Antarctic circle, is the *South Temperate Zone*.

FRIGID ZONES.—On those belts lying between the polar circles and the poles, the sun's rays fall *very obliquely*, and that for only half the year; hence they are colder than the temperate zones, and are called the *frigid zones*. The one north of the Arctic circle is the *North Frigid Zone*, the one south of the Antarctic circle is the *South Frigid Zone*.

VARYING LENGTH OF DAYS AND NIGHTS.—When the sun's rays fall perpendicularly upon the equator, the day circle coincides with a meridian circle, and divides the equator, and each of the parallels, into equal parts; hence, the days and nights are equal in all parts of the earth.

But when the sun's rays fall perpendicularly on either tropic, the day circle divides those parallels between the polar circles, into unequal portions; hence, the days and nights are unequal in length, except at the equator.

As the equator is a great circle, and the day circle is practically a great circle, they divide each other into equal parts at all times; hence, the days and nights at the equator are of uniform length during the year.

At $41^{\circ} 24'$ N. or S. latitude, the longest day is 15 hours, and the shortest 9 hours. At $66^{\circ} 32'$ N. or S. latitude, the longest day is 24 hours. At the poles, the days and nights are each six months in length.

If the teacher will take a circular piece of card-board, cut a hole in it so that it will just pass over a globe or ball on which the parallels are represented, place it so that it will represent the position of the day circle on June 21st, the equal division of the equator, the unequal division of the parallels between the polar circles, and the non-division of the parallels within the polar circles will be evident, and the whole matter of the varying length of day and night in different portions of the earth at different times in the year, will be clearly understood.

SEASONS.—On the 21st of June, the sun's rays fall perpendicularly on the tropic of Cancer; it is then Summer and day, in the North Frigid Zone; Summer, with long days and short nights in the North Temperate Zone; wet season, with nearly equal days and nights in the North Torrid Zone; dry season, with nearly equal days and nights in the South Torrid Zone; Winter, with short days and long nights in the South Temperate Zone; Winter and night in the South Frigid Zone.

On the 21st of December, the sun's rays fall perpendicularly on the tropic of Capricorn, and the above conditions are reversed.

The temperate zones have Spring and Autumn, between their Summer and Winter.

The location of the tropics and polar circles, the varying length of days and nights, and the changes of the seasons, depend upon the revolution of the earth around the sun, and the inclination of the axis.

The teacher should *very carefully* illustrate this with a globe, so that each pupil may clearly understand the relation of cause and effect as stated above.

In studying the solar system we have learned of the *relative* position, form, size, and motions, of the earth as compared with the other members of the system.

In studying mathematical geography we have learned of the *actual* form, size, and motions of the earth, together with the effects of these motions.

The following diagram presents to the eye an outline of the topics of the preceding lessons:

EARTH.

POSITION. 93 millions of miles from the sun.

FORM.....

{ Apparent, flat.
 Actual, oblate spheroid PROOFS. { Actual measurement.
 { Experiments with pendulum.
 General, spherical. PROOFS. { Shadow on the moon.
 { Uniformly increasing size of horizon as we ascend.

SIZE.....

{ DIAMETERS, { Long, 7925.604 miles.
 { Short, 7899.114 miles.
 { CIRCUMFERENCES, { Long, 24899.022 miles.
 { Short, 24857.5 miles.

MOTIONS.

{ ROTATION. { Direction, from west to east.
 { Time. { Solar day, 24 h.
 { Sideral day, 23 h. 56 m. 4.1 secs.
 Effects.....

REVOLUTION.

{ Direction, from west to east.
 { Time, one year.
 Effects of { Revolution alone, orbit, plane or orbit, and year, 365 da. 5 h. 48 m. 48 sec.
 { Revolution and Inclination of axis. { Position of tropics and polar circles.
 { Apparant motion of { Sun.
 { Day circle.
 { Varying length of day and night.
 { Changes of the seasons.

PHYSICAL GEOGRAPHY.

PHYSICAL GEOGRAPHY is the study of the *land, water, air,* and *life* of the earth, not only as *separate* wholes, but as *parts* of one *organic* whole, in their *mutual* relations.

A large number of the phenomena met with in physical geography, are caused by *heat*.

SOURCES OF HEAT.—The principal sources of heat are the *sun, combustion, and mechanical action*.

EFFECTS OF HEAT.—Heat, when applied to a body, not only warms it, but expands it. When the heat is removed, the body cools and contracts.

HEAT EXPANDS IRON.—The blacksmith heats the tire of the wheel, and it becomes too large for the wheel; he pours cold water on the heated tire, it cools, contracts, and fits the wheel closely.

HEAT EXPANDS WATER.—Fill a small flask with water, cork it, and through the cork pass a small glass tube; apply heat to the flask and the water not only becomes warm, but rises in the tube; remove the heat, the water becomes cool and sinks in the tube; thus showing that water expands when heated, and contracts when cooled.

HEAT EXPANDS AIR.—Empty the water from the flask used in the last experiment, re-cork it, place the free end of the glass tube under water, and apply heat to the flask; the air be-

comes warm, and the bubbles formed in the water show that the air is being forced out of the tube through the water; remove the heat, the air cools, no more bubbles are formed, but the water rises in the tube; thus showing that air expands when heated, and contracts when cooled.

HEAT EXPANDS NEARLY ALL BODIES.—It can be shown that heat expands *nearly all* bodies, whether solid, liquid, or gaseous.

TRANSFER OF HEAT.—Heat is transferred from one body to another in four ways; by *conduction*, *convection*, *radiation*, and *reflection*.

CONDUCTION.—Put one end of a wire in the fire, hold the other end in the fingers, and the end in the fingers will soon be warmed. The heat is carried by the wire from the fire to the fingers. First, the particles of the wire in the fire are warmed, these warm those next to them, and so on till those between the fingers are warmed without any sensible movement of the wire.

The carrying of heat from one body to another *without* sensible movement of the carrying body, is called *conduction*.

Dense bodies, as the metals, silver, copper, iron, etc. are good conductors.

CONVECTION.—If a particle of air or water becomes warmer than other particles near it, it expands and is lighter bulk for bulk than the neighboring particles; these, therefore, crowd it upward, and in its passage, it warms those particles with which it comes in contact.

The carrying of heat from one body to another, *with* a sensible movement of the carrying body, is called *convection*.

Liquids and gases are good conveyors of heat. Water and air, are, for the most part, warmed by convection.

RADIATION.—Heat comes to us from the fire or the sun when there is no sensible substance to bring it by conduction or convection. It comes in straight lines, as is shown by the fact that a very small screen will protect us from the heat of the fire or the sun.

The sending of heat from its source without any sensible body to carry it is called *radiation*.

Bodies sending off heat in this way are called *radiators*, and such heat is called *radiant* heat.

All bodies, however hot or cold, are said to be radiators.

The intensity of radiant heat depends upon the degree of heat in the source, the distance of the source, and the directness with which the rays fall; the more direct the rays, the more intense the heat.

REFLECTION.—At noon, when the sun is shining, it is warmer on the south side of a building, than in an open field. When near the building you receive the same number of rays from the sun that you do in the open field, and in addition to these, some of the rays which fall upon the building are *thrown back* upon you; thus you receive heat from two directions.

The throwing back of heat in this manner is called *reflection*, and bodies that throw it back are called *reflectors*. To be a good reflector, a body must have a smooth surface.

The surfaces of dense bodies, as metals, may be made very smooth, hence, metals may be good reflectors.

ABSORPTION.—If heat falls on a body it may be reflected, and not enter the body, or it may enter the body and warm it, *i. e.* it may be *absorbed*.

If heat goes into a body, it must go in by conduction, hence good conductors, as metals, must be good absorbers; if the surface is smooth, the heat will be reflected; if the surface is rough, the heat will be absorbed; *i. e.* whether a body is a good reflector or a good absorber, depends upon the character of its surface.

Good *absorbers* are good *radiators*.

DIATHERMIC BODIES.—If heat falls on a body, it may pass through it and not warm it; as, the heat of the sun will pass through the glass and warm the window-sill, warming the glass but slightly. Bodies which let heat pass through them in this manner, are called *diathermic bodies*. Air, glass, and rock-salt are examples of diathermic bodies

THERMOMETER.—We can tell by the sense of feeling that some bodies are warmer than others; but if we wish to know *exactly* how much warmer one body is than another, we must use a *thermometer*, or heat measurer, which is constructed on the principle that heat expands, and cold contracts bodies.

The thermometer in common use, consists of a glass tube with a bulb at one end filled with mercury and the vapor of mercury, and sealed up at the other end. Behind the tube is a graduated scale to show how high the mercury stands in the tube. When the bulb is placed in a mixture of snow and salt, the point at which the surface of the mercury stands is marked (o); when placed in boiling water the point at which it stands is marked 212; the space between these two points is divided into 212 equal portions, called degrees, marked thus, ($^{\circ}$). 32° is the freezing point of water.

TEMPERATURE—Temperature is the amount of heat which a body possesses, as measured by the thermometer.

THE FORM OF A BODY DEPENDS ON ITS TEMPERATURE.—If we apply heat to a solid, as ice, lead, or iron, it at length becomes liquid; and if the heat is continued, the liquid at length becomes a gas. If the heat is withdrawn, the gas cools, becomes a liquid, and, at length, a solid again.

Facts have been observed which show that there is within the earth a great mass of molten matter. These facts, together with others, led philosophers to adopt, in explaining the origin of the earth, its locality, form, size, and motions:

THE NEBULAR THEORY.—This theory supposes that the solar system was once a mass of burning gas; as it radiated heat, cooled, and contracted, rotary motion was generated or

created; as the contraction continued, the motion increased, till some of the outside portions were thrown off, for the same reason that water is thrown off from a rapidly turning grindstone. Nine or ten bodies were thrown off in this way, each rotating on an axis, assuming a spherical form, and revolving around the central mass. Some of these rotated so rapidly that bodies were thrown off from them, having similar form and motions. These bodies, at first gaseous, as they cooled became molten liquid bodies, and around some of them a solid crust was formed, as in the case of our earth.

PROOFS OF THE THEORY.—The spectroscope shows that there are now masses of burning gas in the heavens; that the sun is a mass of liquid molten matter, and that the sun contains many substances found in our earth.

By means of the telescope we find that the different members of the solar system have the form and motions supposed in this theory. These facts, together with others, give us good ground for accepting the theory.

GEOLOGICAL HISTORY OF THE EARTH.—According to our theory the earth was once a liquid molten mass. As it cooled, at length a continuous crust was formed. At first this crust was thin and hot, so that all the water, sulphur, and many of the acids formed a thick vaporous atmosphere about the earth. As the crust continued to cool, the vapors condensed and fell upon the crust, forming vast oceans of hot, sulphurous, acid water. As the crust cooled and contracted, it pressed upon the fluid mass within till some of the weaker portions gave way and broad elevations were formed, and great quantities of fluid molten matter were thrown out. Thus the *continents* were formed; not high and mountainous as now, but for the most part just below the level of the water, yet having the same general outline as now. These ancient continents were mostly composed of granitic rocks. The heavy waves of the sea broke down the more elevated portions, and spread them over its bed in assorted layers of material for

gneiss, quartz, and slate rocks; other portions, uniting with the acids of the water, formed sediments which settled as material for marble and other kinds of rock; thus purifying the water. As these layers and sediments thickened, the pressure from above, and the heat from below, changed them into the different kinds of rock. Thus the air and water became fitted for the lower forms of vegetation, such as seaweeds. There was, however, so little life during all this *first age*, that it has been called the *azoic age*, or age without life.

SECOND AGE.—Soon the sea became fitted for the lower forms of animal life, such as the various kinds of shell fish, called mollusks. The sea must have swarmed with this kind of life, since the remains of their shells have formed vast beds of limestone thousands of feet in thickness. This age is called the *age of mollusks*.

During this age the Green Mountains were formed, and, great cracks opened in the region of Lake Superior, were filled with matter from the molten interior, in which are found the copper, silver, and iron of that region.

THIRD AGE.—The mollusks, gathering carbonic acid from the air, and lime from the water to form their shells, fitted the air and water for still higher types of life. During this age great numbers of gigantic fishes, the first representatives of vertebrate animals, appeared in the sea; and on the land, the first land-plants and insects made their appearance. This age is called the *age of fishes*.

The rocks formed during this age were mostly sandstone, shale, and limestone.

FOURTH AGE.—The forms of life which appeared during the third age, continued in this, and a few reptiles appeared; but the age was characterized by its rank, luxuriant vegetation. The vegetation consisted of the lower forms of plant life, such as ferns and rushes, but they were of gigantic size. The air was warm, moist, and charged with carbonic acid; large

tracts of land were covered with shallow, stagnant water,—conditions favorable to a rank growth of vegetation. The mosses, and leaves of larger plants, preserved from decay by the water, formed beds of peat. The crust settled, and ocean currents spread sediments of clay, sand, or limestone over the peat. The crust rose again, another bed of peat was formed, which in turn was covered with sand or clay, and so on, until in some instances as many as sixty or seventy alternate layers of peat, clay, sand, &c. were formed. The peat, saturated with water, and subjected to great heat and pressure, formed bituminous coal; more heat and pressure changed the bituminous coal to anthracite coal.

This age is called the *carboniferous, or coal-bearing age*.

Toward the close of this age, the Appalachian and Ural Mountains were formed. The thickness of the sediments deposited during this and the preceding ages was from five to nine miles. These sediments seem to have been deposited in shallow water, the crust settling as the sediments thickened.

FIFTH AGE.—The plants, during the *fourth age*, gathered vast quantities of carbonic acid from the air, the ocean sediments buried it away in the earth, thus purifying the air for still higher forms of life. The life of the *fifth age* was characterized by huge, crawling, swimming, flying reptiles. It is called the *age of reptiles*. Birds, and other warm blooded animals, and flowering plants also appeared during this age; the Rocky Mountains, the Andes, the Alps, and a large part of the Himalayas were elevated. These great disturbances destroyed all life except a few deep-sea fishes. The characteristic rocks of this age were the green-sand of New Jersey, and the soft, shaly limestone found in Georgia, Texas, and the Western Plains.

THE SIXTH AGE, or age of mammals.—The huge reptiles were succeeded by huge mammals; as, the mastodon, mammoth, elephant, Irish elk, gigantic birds, &c., animals resemb-

ling those we have now, only much larger. Forests of beech, oak, and pine, and other vegetation nearly the same as now, existed. During this age the *glacier*, nature's icy plow, ground down the rocks into soil; the prairies were formed; the air and the water were pure, and every thing ready for the advent of man, nature's crowning work.

We have seen that a large portion of the crust was deposited in horizontal layers at the bottom of the sea; but as the crust was thrown up into mountains, these layers were broken up, so that now they may be found at almost any angle with the horizon; that vast cracks in the crust, filled with matter from above or below, are veins which contain most of the useful and precious metals; that the condensation of vapors, and the formation of sediments, fitted the air and water for the lowest forms of vegetation, which derived their nourishment from the mineral kingdom; that these not only helped to purify the air and water, but became food for higher forms of plant life, and for the lower forms of animal life; that these in turn supplied the conditions for still higher types of life; and so on, until the earth was fitted to be the abode of man.

But nature did not pause in her work at the coming of man; beds of coal and layers of rock are still being formed; the crust of the earth is rising in some places, and settling in others; old forms of animal and vegetable life are passing away, and new ones are appearing; birds, insects, and plants exist in greater variety and number than ever before. Thus patiently, slowly, but surely, nature is day by day working out the designs of the Creator.

We have briefly traced the history of the earth from the beginning of its development to the present time, and with this general view in our minds we may now enter upon the study of the different parts of the earth in detail.

PARTS OF THE EARTH.

The earth consists of:

1. The *surface*;
2. The *air* outside the surface;
3. A *molten interior*.

THE SURFACE.—The surface is that portion of the crust of the earth which can be examined and made useful to man.

THE LAND AND SEA.—The surface is not uniform, but consists of elevations and depressions; the elevations we call the *land*; the depressions filled with water we call the *sea*.

THE SEA.—The sea occupies about three-fourths of the earth's surface. The surface of the sea is uniformly curved, and is called the *sea-level*. This level changes but slightly, and is used as a basis from which to measure the elevation of the land, and the depth of the sea.

OCEANS.—For convenience of description, the sea is divided into five *oceans*.

NAMES AND RELATIVE SIZE OF THE OCEANS.—Dividing the water surface of the earth into one hundred equal parts, the Pacific Ocean comprises *fifty* parts, the Atlantic *twenty-five*, the Indian *seventeen*, the Antarctic *five*, the Arctic *three*.

THE LAND.—The land is not all in one body, but is distributed into a great number of separate masses, varying greatly in size.

CONTINENTS.—The three larger masses are called *continents*, named the Western, Eastern, and South-Eastern.

GRAND DIVISIONS.—The Western and Eastern continents are naturally divided as follows: the Western into *North America* and *South America*; the Eastern into *Europe*, *Asia*, and *Africa*; the South-Eastern, is called *Australia*. These six bodies of land are called *grand divisions*.

RELATIVE SIZE OF THE GRAND DIVISIONS.—Dividing the land surface of the earth into one hundred equal parts, Asia comprises *thirty-two parts*, Africa *twenty*, North America *sixteen*, South America *thirteen*, Europe *seven*, and Australia *six*.

The teacher should require the pupil to locate the grand divisions with reference to each other, and with reference to the oceans; to locate the oceans with reference to each other, and with reference to the grand divisions, and to locate both with reference to the hemispheres.

ISLANDS.—The smaller masses of land are called *islands*; they comprise about *six* one-hundredths of land.

Islands are divided into three classes,—*continental*, *oceanic*, and *coral*.

CONTINENTAL ISLANDS.—Continental islands are those which are situated along the borders of the continents, seeming to be detached portions of them, and having the same general characteristics as the continents along which they lie; as, the British Isles, the West Indies, and the East Indies.

OCEANIC ISLANDS.—Oceanic islands are those which are situated in mid-ocean; as, the Sandwich Islands, the Cape Verde Islands, and the Island of St. Helena.

CORAL ISLANDS.—Coral islands are islands made by the coral insect, in warm, shallow water, along the shores of continents or of other islands; as, the Laccadive Islands, and Florida Reefs, along the shores of continents; the reefs about the Molucca Islands, New Guinea, the Sandwich Islands, and the Society Islands, are examples of coral islands along the borders of other islands.

LAND.

In studying the land masses, we must study their *horizontal shape*, and their *forms of relief*.

HORIZONTAL SHAPE.—By horizontal shape is meant the length and breadth of the mass, without reference to elevation. This shape is determined by the coast line, *i. e.* the line where the land and water meet. The coast line is an irregular curved line; its irregularity is caused by projections from the land and from the water.

Projections from the land are called *capes* and *peninsulas*

CAPES.—Capes are small, wedge-shaped projections from the land; as, Cape Mendocino, Cape St. Roque, Cape Matapan, Cape Comorin. A high, rocky cape is called a *promontory*.

PENINSULAS.—Peninsulas are projections from the land, which are larger than capes, and are generally more nearly surrounded by water; as, Florida, Arabia, Italy, &c.

THE PROJECTIONS FROM THE WATER are called *gulfs*, *bays*, and *seas*; as, the Persian Gulf, Hudson Bay, Mediterranean Sea, etc.

The coast lines of North America, Europe, and Asia are very irregular, on account of numerous projections from land and sea, especially along the Arctic Ocean; while the coast lines of South America, Africa, and Australia are comparatively regular. About one-fourth of Europe, one-fifth of Asia, and one-fourteenth of North America consist of peninsulas; while there are scarcely any peninsulas in South America, Africa, and Australia.

Connecting bodies of land and water are called *isthmuses*, and *straits*.

AN ISTHMUS.—An isthmus is a narrow body of land connecting two larger bodies of land; as, the Isthmus of Suez and the Isthmus of Panama.

A STRAIT.—A strait is a narrow body of water connecting two larger bodies of water; as, the Strait of Gibraltar and Behring Strait.

FORMS OF RELIEF.—By forms of relief we mean the elevations of the land above the sea-level. Under forms of relief are included *low plains*, *plateaus*, and *mountains*.

LOW PLAINS.—Low plains are broad tracts of land which have an elevation of less than 1000 feet above the sea-level; as, the low plains of the Mississippi and Amazon Rivers, the low plains in the northern part of Europe and Asia, and those along the coasts of Africa and Australia.

The surface of low plains is usually quite level, though moderate elevations sometimes occur.

A low plain is bounded on one side by water, and on the other by a plateau.

PLATEAU.—A plateau is a broad tract of land which has an elevation of more than 1000 feet above the sea-level; as, the Colorado Plateau, the Plateau of Brazil, and the Plateau of Thibet.

The surface of a plateau is more uneven than that of a low plain; the elevations upon it are more numerous, and of greater height. Plateaus vary greatly in elevation and extent; in elevation, from 1000 to 15000 feet, and in extent, from a few miles to many thousands of miles.

A plateau is bounded by low plains and mountains, or by mountains alone.

MOUNTAINS.—Mountains are narrow bodies of land having an elevation of more than 2000 feet above the sea-level; they may be *isolated* mountains; as Katahdin, Egmont, and Pop-

ocatepetl; or a number of mountains may be joined together, forming a *chain*; as, the Blue Ridge, and the Carpathian Mountains; or, a number of chains lying near each other forming a system; as, the Appalachian Mountain-System and the Alps.

If the elevations are less than 2000 feet above the sea-level, they are called *hills*.

The parts of a mountain are the *summit*, or highest point, which may be either broad and flat, or narrow and pointed; the *base*, where the ascent commences; and the *slopes*, or the sides from base to *summit*; they vary greatly in steepness.

In studying a mountain, we must consider its location, elevation, summit, slopes, and base; as, Pike's Peak is located in the western part of the United States; its elevation is about 14000 feet; the summit is broad and flat; the slope on the east is very steep; on the north, west, and south it is more gradual; the base, on the east is clearly defined, the mountain rising abruptly from the plain, on the other sides it is obscured by ranges of hills.

VOLCANOES.—Volcanoes are mountains or hills with basin-shaped depressions, or craters, in their tops or sides. Leading from the craters toward the centre of the earth, are *passages* through which are thrown out great masses of molten rock, called *lava*, red-hot stones, ashes, sand, smoke, gases, and in some instances great quantities of water.

Mt. Vesuvius, in Southern Italy, is one of the most noted volcanoes. Its first known eruption was in the year 79 A. D. The ashes, lava, etc. thrown from it at this time, buried the three cities of Pompeii, Herculaneum, and Stabiae. Since that time many eruptions from Vesuvius have occurred, the last in 1872; none, however, so destructive in their effects as the first.

A large number of volcanoes depend for their form upon the character of the material thrown out by them; if mostly lava, the cone will be comparatively flat; if mostly ashes and sand, it will be steeper.

NUMBER AND LOCATION.—There are about 650 volcanoes, of which about 250 are *active*; and the others are *inactive*. Most of the volcanoes are found along the sea shore, and a large portion of these, are found in a belt encircling the Pacific Ocean; including the volcanoes of South America, North America, the Aleutian Islands, and the islands bordering the eastern portions of Asia and Australia. There are also volcanoes in Iceland, the West Indies, the Sandwich Islands, and some other localities.

EARTHQUAKES.—Earthquakes are vibrations or tremblings of the earth's crust; sometimes the movement is very slight, at others, very violent, causing great destruction.

The earthquake at Lisbon was one of the most destructive on record. The city was wholly destroyed in a very few minutes, and more than 60,000 persons perished. The extent of surface disturbed by this earthquake, was equal to nearly four times the area of Europe.

Earthquakes occur most frequently in volcanic regions, although no region is entirely exempt from them.

CAUSE OF VOLCANOES AND EARTHQUAKES.—From the location of volcanoes and earthquake regions, these phenomena are supposed to be caused by steam, formed from water coming in contact with the molten interior.

The summit of a mountain chain is called the *crest*. Depressions in the crest are called *passes*. The elevations between the passes are called *peaks*.

In studying a *mountain chain* we must consider its location, elevation, extent, direction, crest, passes, peaks, slopes, etc.; as, the Rocky Mountains are situated in the western part of North America; they have an elevation of from 9,000 to 10,000 feet; they extend about 3,500 miles in a N. W. and S. E. direction, from the head waters of the Rio Grande River to the Arctic Ocean; the crest is very irregular; there are many passes, the most important of which is the South Pass; there are also numerous peaks rising to an elevation of from 12,000 to 14,000 feet; as, the Spanish Peaks, Long's Peak, Fremont's Peak, etc.; the eastern slope is usually more abrupt than the Western.

In studying a *mountain system* we must consider its location, the parts of which it is composed, its general elevation, and its extent.

PRIMARY AND SECONDARY SYSTEMS.—That mountain system of any grand division which has the greatest elevation and extent, is called its *primary system*; as, the Andes, Alps, and Himalayas; the others are called *secondary systems*; as, the Appalachian Mountains, the Brazilian Andes, the Carpathian Mountains, etc.

VALLEYS.—Valleys are the depressions between the chains which constitute a mountain system; as, the Shenandoah Valley in Virginia, and the Valley of the Ebro in Spain.

The term valley, is sometimes applied to depressions between mountain systems; as, the Mississippi Valley.

Pupils should be required to locate accurately, all places named in these illustrations.

THE SEA.

BED OF THE SEA.—The bed of the sea has its forms of relief, the same as the land surface.

DEPTH.—Since the bed of the sea is irregular, the *depth* varies; in some places it is from five to six miles.

COMPOSITION OF SEA WATER.—In 100 parts of sea water, there are, of

Water	96.2;
Salt.....	2.7;
Magnesia	.6;
Lime.....	.1;

also traces of silver, copper, iron, iodine, etc. The composition varies slightly in different parts of the sea, less solid matter being found near the mouths of large rivers and toward the poles.

MOVEMENTS OF THE SEA.—The sea is subject to three movements: waves, tides, and currents.

WAVES.—Waves are movements of the sea caused by the winds.

NOTE.—Winds are currents of air caused by the unequal heating of the air in different parts of the earth. The subject of the winds will be more fully discussed under the appropriate head.

In this movement the *wave* has a forward motion, but the *water* has very little motion other than upward and downward; as, in shaking a carpet, the waves formed move the whole length of the carpet, while the carpet itself moves only upward and downward.

When waves, advancing toward the shore, reach the shallows, the motion is retarded at the bottom by friction; and the top moving on without support, breaks over in foam upon the shore, thus forming what are called *breakers*.

The *force* and *hight* of waves vary with the force of the winds. It has been estimated that the waves sometimes beat upon the shore with a force of 5,000 or 6,000 pounds to the square foot.

The *crest* of a wave is its highest part; the *trough* is the depression between two waves, and is as much below the general level, as the crest is above. The hight of the waves, from trough to crest, has never been known to exceed 35 or 40 feet.

The *effects* of this movement are to modify the coast-line, and to aid in purifying the water.

TIDES.—Tides are waves caused by the attraction of the sun and moon.

It seems easy to see how the attraction of the moon should cause a wave on the side *toward* the moon; but there is a wave of equal hight on the *opposite* side. How is this accounted for?

The weight of a body is the measure of the excess of the earth's attraction for it, over the attraction of all other bodies for it. Since attraction varies inversely as the square of the distance from the centre of attracting body, the farther a body is from the centre of the earth, the less it will weigh. The attraction of the moon upon the water, overcomes a portion of earth's attraction for it, making the water on the side next the moon lighter. The attraction of the moon also has the effect to shift the centre of the earth's attraction, from the centre of the earth toward the moon. This leaves the water on the opposite side farther from the centre of attraction; hence, it is lighter.

The circum-polar, and other waters at right angles to the direction of the moon's attraction, are nearer the centre of the earth's attraction, than the waters opposite the moon; hence, are heavier than they. These waters, therefore, by reason of their greater weight, force the lighter waters up *toward* the moon on the one side, and *from* the moon on the *opposite* side; thus the opposite tidal waves are accounted for.

As the moon revolves about the earth once in about 27 days, these waves make the circuit of the earth in the same time. The earth rotates once in 24 hours, in the same direction

in which the moon revolves. During one rotation of the earth, the moon moves forward, so that it takes the earth about 52 minutes to reach the same position with regard to the moon, that it had the day before; *i.e.* the moon rises 52 minutes later each day. As the tidal waves follow the moon, any given place passes through the crest of both tidal waves once in 24 hours and 52 minutes, reaching the crest of a given tidal wave 52 minutes later each day.

FLOOD AND EBB TIDE.—When a place is passing from the trough to the crest of a tidal wave, it is called *flood tide*; at that place.

When passing from the crest to the trough, it is *ebb tide*.

When *in* the crest it is called *high water*, or *high tide*; when in the trough, it is *low water*, or *low tide*.

Thus far we have considered the tide caused by the moon, but the sun causes a tide in the same manner as the moon does.

The tide caused by the moon, which is called the *lunar tide*, is much greater than that caused by the sun, which is called the *solar tide*.

During each revolution of the moon, it is once on the side of the earth toward the sun, and once on the side opposite the sun. At these times the crests of the tidal waves formed by each, will coincide, and much higher tides will be formed, called *spring tides*.

Twice during the revolution of the moon, the crests of the lunar tidal waves, coincide with the troughs of the solar tidal waves, and we have very low tides, called *neap tides*.

HIGHT OF THE TIDES.—The solar and lunar tidal waves together, are, in mid-ocean about three feet high; but owing to the motion of the earth, the water heaps up on the eastern side of the continents, rising to the hight of 8 or 10 feet; and in some rivers, as high as 20 or 30 feet; and in the Bay of Fundy as high as 75 feet.

The tides have the same effects as ordinary waves, and in some localities form currents.

CURRENTS.—Waves and tides are mainly an upward and downward movement of the water, but *currents* are vast bodies of water having a progressive movement, in definite directions, with a velocity varying from 3 or 4 miles per hour, to less than one mile per day.

CAUSES OF CURRENTS.—Currents are caused by the unequal heating of the water, by winds, the rotation of the earth, tides, and evaporation.

The waters of the torrid region, becoming heated, expand and are lighter, bulk for bulk, than those of the polar regions. These colder waters, crowding the warm waters from their place, form currents.

The vast body of water around the south pole, is the main supply of ocean currents.

A current, called the Antarctic Drift Current, flowing from the south pole toward the north-east, strikes against the western shores of the continents, and is reflected toward the west, and under the influence of rotation and the trade winds, becomes a strong western current, in both the Atlantic and Pacific Oceans, called the *Equatorial Current*.

In the Atlantic Ocean, the equatorial current divides off Cape St. Roque, one part flowing south along the coast of South America, as the Brazilian current, which sends off a branch to the east; called the *southern connecting current*, which joins the Antarctic current, thus making the circuit of the South Atlantic Ocean. The other portion of the equatorial current passes along the north coast of South America, through the Caribbean Sea, into the Gulf of Mexico. From the Gulf of Mexico, through the Strait of Florida, as the Gulf Stream, it flows north-east along the coast of North America as far as latitude 40° N., where it turns more directly east, dividing off the coast of France, one branch flows north-east along the west coast of England, into the Arctic Ocean; the other branch flows toward the south-east along the coast of Europe and Northern Africa, joining the equatorial current, thus completing the circuit of the North Atlantic Ocean.

In the Pacific Ocean that part of the Antarctic current flowing along the western coast of South America, as the *Peruvian* current, near the equator, turns westward as the *equatorial* current. This divides off the East India Islands, one portion flowing south and south-east, as a connecting current, joins the Antarctic current, thus making the circuit of the South Pacific Ocean; the other portion flows north-east along the coast of Asia, as the Japan current, sending a branch north-east through Behring Strait into the Arctic Ocean, and another south-east and south along the coast of North America, till it joins the equatorial current, thus making the circuit of the North Pacific Ocean.

The waters of the Antarctic current, as they leave the pole, are very cold, but coming into the equatorial region, they are heated, so that the equatorial currents, the Gulf Stream, and the Japan current, are warm currents.

We have currents from the Arctic Ocean also; one from the north of Asia, flows south-west along the east coast of Greenland, uniting with one flowing south along the west coast of Greenland, forms the Labrador current, which continues south along the east coast of North America, and passes under the waters of the Gulf Stream between 40° and 50° north Latitude. Another Arctic current passes through Behring Strait, and around the Aleutian Islands, mingling with the Japan current in 50° N. Lat.

The heated air of the torrid zone, crowded up by the colder air of the polar region, gives rise to winds, which, on account of the rotation of the earth, come from the north east and south east. These winds blow constantly from these directions, and aid in forming the equatorial current. They are called the *trade winds*. During the Summer, the southern parts of Asia become very hot; the cool air of the Indian Ocean pressing in crowds up the warm air, causing the Monsoon winds from the south-west. In Winter, the southern parts of Africa become heated, and north east Monsoon winds occur.

CURRENTS OF THE INDIAN OCEAN.—The Antarctic current reflected from the coast of Australia, forms an equatorial current, the southern branch of which flows south past Madagascar, then south-east, joining the Antarctic current, thus making the circuit of the southern part of the Indian Ocean. The northern branch is broken up for most of the year by the Monsoon winds, which cause currents in the direction in which they blow

CURRENTS CAUSED BY TIDES.—At Quebec, on the St. Lawrence River, when the tide is rising, the current is up the river; when the tide is falling, the current is down the river, *i. e.* the tide causes a current both ways twice every 24 hours and 52 minutes. The same is true of the mouths of other large rivers, and of narrow channels.

The tidal currents, and those caused by the Monsoon winds, are *periodical* currents; the polar, equatorial, and Japan currents, and the Gulf Stream are *constant* currents.

SARGASSO SEAS.—In the Southern Hemisphere, the water moves from the east toward the west, and by the south back toward the east again. In the Northern Hemisphere, the water moves from the east toward the west, and by the north back toward the east again. Within the five circuits described, are vast areas of quiet water, where are found vast quantities of drift material and sea-weed. These areas are called *Sargasso*, or *grassy seas*.

CURRENTS OF THE RED SEA.—The heat of the torrid zone causes some of the water of the Red Sea to take a gaseous form, *i. e.* a portion of it *evaporates*, leaving the rest more dense. A current flows in from the Indian Ocean to supply the waste by evaporation. The denser water, left by evaporation, sinks, and flows out into the ocean as an under current. For the same reason, similar currents occur in the Mediterranean Sea.

EFFECTS OF CURRENTS.—Currents have the effect to modify the coast line, to equalize the temperature of the ocean, to modify the temperature of the land, and to aid in commerce.

THE AIR.

The atmosphere or air is an invisible gas surrounding the earth.

COMPO- SITION.	{	Oxygen, 23.17 parts in 100, by weight.	}	Pure air.
		Nitrogen, 76.83 parts in 100, by weight.		
		Water, 1 part in 100, by weight.	}	Dissolved
		Carbonic acid, .0006 of a part in 100.		in the air.

Pure air is composed of oxygen and Nitrogen only: but water, carbonic acid, ammonia, nitric acid, and many other substances are always found in the air in small, but varying quantities.

WEIGHT OF AIR.—One hundred cubic inches of air weigh 31 grains.

PRESSURE OF AIR.—At the level of the sea, the pressure of the air is 15 pounds to the square inch; at an elevation of 12,600 feet, it is $7\frac{1}{2}$ pounds to the square inch; at 25,200 feet, it is about $3\frac{1}{2}$ pounds to the square inch.

CLIMATE.—Climate is the condition of the air as regards temperature, moisture, and purity.

HOW HEATED.—The air is heated somewhat by heat radiated or reflected from the surface of the earth, and by heat radiated from the sun; but mainly by convection from the surface of the earth.

Since the surface of the earth is the great source of heat for the air, it must be colder as we ascend from the surface. Thus, as we go from the equator toward the poles, or from the surface upward, the temperature decreases.

MEAN ANNUAL TEMPERATURE.—If we note the temperature, in degrees, of each day during the year, for any given place, the *average* of these temperatures will be the *mean annual temperature* for that place.

The M. A. T. (mean annual temperature) of a place varies but little from year to year.

ISOTHERMAL LINES.—Isothermal lines are lines extending around the earth from east to west, connecting places of the same M. A. T. They do not coincide with the boundaries of the parallels, on account of the forms of relief and the ocean currents.

EFFECT OF OCEAN CURRENTS ON THE TEMPERATURE OF THE LAND MASSES.—On the eastern coast of North America, the Arctic currents crowd the isothermal lines toward the south; on the eastern coast of South America, the Brazilian current crowds them toward the south; on the western coast of South America, the Antarctic current crowds them toward the north; on the western coast of North America, the Japan current crowds them toward the north; thus on the east coast of the west continent, the isothermal lines, in the N. Hemisphere, are crowded toward the *south* by cold currents, and in the S. Hemisphere by warm currents: on the west coast, in the S. Hemisphere, they are crowded *north* by cold currents, and in the N. Hemisphere by warm currents, hence, the isothermal lines, in crossing the Western Continent, trend from the south-east toward the north-west.

The isothermal lines, in crossing the other continents, follow the same direction, for similar reasons.

Thus it is seen that the principal reason for the variation of the isothermal lines from the boundaries of the parallels, is the ocean currents.

The student should study carefully the map of isothermal lines, on pp. 74 and 75 of Guyot's Physical Geography, or that of some other author. From this he will learn that the *greatest M. A. T.* is found in the neighborhood of the Carribbean Sea, the Red Sea, and in the peninsula of Hindoostan; i. e. the line of greatest heat is from 40° to 10° north of the equator.

WINDS.—Winds are currents of air caused by the *unequal heating* of the air, in different parts of the earth.

Winds are either *constant*, *periodical*, or *variable*.

CONSTANT WINDS.—In the region of greatest heat, the air is lighter, bulk for bulk, than that either north or south. The heavier air crowding up the lighter air, causes winds, which, if the earth did not rotate, would come directly from the north and from the south. In the rotation of the earth, places near the equator move more rapidly than those toward the poles; hence, winds having the motion of places toward the poles, as they approach the equator, fall behind places having the same longitude as those from which they started; therefore, they do not come directly from the north and south, but from the north-east in the N. Hemisphere, and from the south-east in the S. Hemisphere. Since the causes are constant, the winds are constant.

REGION OF CALMS.—In the region of greatest heat, the air is constantly ascending, and we feel no current; hence, it is called the *region of calms*.

This region is about 4° in width; its location varies as the sun is north or south of the equator; it is usually found between 2° and 12° North Latitude.

The air, constantly rising from the region of calms, presses off toward the poles. If the earth did not rotate, it would move directly toward the north and toward the south; but, in the rotation of the earth, places near the equator move more rapidly than those toward the poles; hence, it reaches the higher latitudes as a south-west wind in the N. Hemisphere, and as a north-west wind in the S. Hemisphere. The causes being constant, these winds are constant.

Those constant winds from the north-east and from the south-east are called *lower* constant winds; those from the south-west and from the north-west are called *upper* constant winds.

REGIONS OF CONSTANT WINDS.—The regions of constant winds are each about 22° wide, one north and one south of the region of calms; the one north, extending to about 32° North Latitude; the one south extending to about 22° South Latitude. Their location varies as the location of the region of calms varies.

VARIABLE WINDS.—Between 30° and 35° North Latitude, and between 20° and 25° South Latitude, the upper constant winds reach the surface of the earth, and, interfering with the lower constant winds, cause *variable winds*. Since the upper constant wind has less friction to overcome, it is the stronger; hence, from about 32° North Latitude, south-westerly or westerly winds prevail; and from about 25° South Latitude, north-westerly winds prevail.

PERIODICAL WINDS.—Periodical winds are either *monsoon winds*, or daily *land* and *sea breezes*.

MONSOON WINDS.—During the Summer, the southern parts of Asia become heated, and the cool air from the Indian Ocean crowding up the hot air, gives rise to the south-west Monsoon, or season wind, which blows from April to October. During Winter the southern parts of Africa become intensely heated, and the cool air from the Indian Ocean, crowding up the hot air, gives rise to the north-east Monsoon, which blows from October to April.

Monsoon winds from north-west and south-east occur between Australia and Asia.

On the Atlantic coast of Africa, monsoons occur from sea to land in Summer, and from land to sea in winter.

There are also narrow monsoon belts along both coasts of the Western Continent between Latitude 30° north and 35° south, but none so marked and interesting as those of the Indian Ocean.

There are more or less marked belts of season winds along the northern and southern limits of the constant winds. On the northern limit, during Summer, north-east winds, and during Winter south-west winds prevail; on the southern limit, during winter, north-west winds, and during Summer south-east winds prevail.

LAND AND SEA BREEZES.—The land is a good absorber of heat, the water a good reflector; hence, during the day, the land becomes much hotter than the sea, which gives rise to a wind from the sea toward the land, called the *sea breeze*. The land is a better radiator than the water; hence during the night it becomes cooler than the water, giving rise to a wind from the land toward the sea, called the *land breeze*. These winds are more marked in the torrid region.

MOISTURE OF THE AIR.—If water is left in an open vessel, it soon dries up, or evaporates, *i. e.* the heat causes it to assume the form of an invisible gas or vapor. The greater the heat, the greater the amount of water in an invisible form. The air does not sustain this invisible vapor; it is sustained in the same manner as that in which the air itself is sustained. If the temperature lowers, some of this vapor condenses into a visible form, as small drops of water, which *are* sustained by the air; if near the earth, they constitute a *fog*; if high in the air, they constitute a *cloud*. If the temperature lowers farther, more vapor condenses, the drops become larger, the air cannot hold them, and they fall slowly as a *mist*. If the temperature lowers still farther, still more vapor condenses, increasing the size of the drops, which fall as *rain*. When the temperature has fallen to 32° , the drops of water freeze, and fall as *snow*, or *hail*.

Toward evening, in Summer, bodies on or near the surface of the earth radiate heat and become so cold that the invisible vapor condenses upon them. This condensed vapor is called *dew*, and the temperature at which the condensation takes place is called the dew-point.

If the radiation continues till the freezing point is reached, the dew freezes, and is then called *frost*.

The greatest amount of rain falls upon the coast of a country where the prevailing winds come from the sea.

Rainless districts occur where the prevailing winds have been deprived of their moisture by passing over high mountains or broad masses of land.

INLAND WATERS.

Inland waters may be divided into *springs*, *lakes*, and *rivers*.

SPRINGS.—A portion of the water taken up by evaporation, condenses and falls upon the land as rain, snow, or hail. A portion of this is again evaporated; another portion sinks into the crust of the earth till it reaches a layer through which it cannot pass; here it accumulates, till, by its weight, it breaks through to the surface again at a lower level, forming what is called a *spring*.

Springs are, 1. Constant, periodical, and variable. 2. Cold, warm, and hot. 3. Lime, iron, salt, soda, sulphur, oil, &c.

A *Constant Spring* is one that flows continually, and suffers little or no diminution from long continued drought.

A *PERIODICAL SPRING* is one that is intermittent in its action, *i. e.* it flows and ceases to flow at regular intervals, and is not much affected by floods or droughts.

A *Variable Spring* is one that flows and ceases to flow at irregular intervals, being much affected by floods and droughts.

A *Cold Spring* is one whose temperature is below 60° .

A *Warm Spring* is one whose temperature is between 60° and 100° .

A *Hot Spring* is one whose temperature is above 100° . The temperature may reach 212° , when it is a *boiling* spring. Sometimes hot springs are spouting springs, as the Geysers, of the Yellowstone, and of Iceland.

A *Lime or Calcareous Spring* is one which contains large quantities of lime in solution. Water having much lime dissolved in it is usually called hard water.

An *Iron or Chalybeate Spring* is one having large quantities of iron in solution. It may be known by the rusty deposits on its borders.

A *Salt or Saline Spring* is one whose waters are impregnated with salt.

An *Alkaline Spring* is one whose waters are impregnated with soda or potassa, and may be known by its bitter taste.

A *Sulphur Spring* is one whose waters are impregnated with sulphur. It may be known by its offensive odor, and sulphurous deposits on its borders.

An *Oil or Petroleum Spring* is one which yields greater or less quantities of oil.

Great numbers of these different kinds of springs are found in nearly all parts of the world.

Periodical springs and Petroleum springs are less numerous than the others.

Water flowing from springs and from depressions in which it has collected during rains, forms *brooks*; a number of these

uniting form a *creek*; a number of creeks form a *river*. A river is a large body of water flowing through a narrow depression in the land.

In studying a river, we must consider its source, course, channel, mouth, etc.

SOURCE.—The source of a river may be a large spring, or a body of water formed by the union of several brooks and creeks; or the snows of some mountain chain may be the source of a river.

The brooks, creeks, and small rivers which flow into and help form a river are called *tributaries*.

COURSE.—The course of a river is the general direction in which it flows; as, the Hudson River has a southerly course.

CHANNEL.—The channel of a river is the depression through which it flows. This is partly natural and partly the work of the river itself. The sides of the channel are called the *banks* of the river. As you go down the river, the one on the left is the left bank, and the other is the right bank. The bottom of the channel is called the *bed* of the river. If the bed is nearly horizontal, the river flows slowly; if somewhat inclined, the river flows more rapidly; if much inclined the river flows swiftly, forming *rapids*; if at any place the bed is vertical, the river flowing over such a place, forms a *fall* or *cataract*.

MOUTH.—The mouth of a river is that part where it flows into some larger body of water. If the mouth is broad and deep it is called an *estuary*. The solid matter brought down by the river sometimes forms low islands at its mouth. These islands divide the river so that it has many mouths instead of one. These islands, together with the divisions of the river, constitute what is called, from its form, a *delta*; as, the delta of the Mississippi River.

SYSTEM.—A river system consists of a river, together with all its tributaries.

That portion of land drained by a river system is called a river *valley*.

The ridge of land which separates one river system or valley from others is called a *water shed*. A water shed may be a mountain chain or only a low swell of land.

LAKES.—Lakes are broad depressions in the land, filled with water. Brooks, creeks, and rivers flowing into a lake are called *inlets*. If a river flows out of a lake it is called an *outlet*.

Lakes which have inlets and an outlet are fresh water lakes. Such lakes often seem to be mere expansions of a river; as, lakes Erie and Ontario. Lakes which have inlets but no outlet, are salt water lakes; as, Great Salt Lake, Dead Sea, etc. The water brought into such lakes by the inlets is removed by evaporation.

Lakes in mountainous regions are usually deeper, in proportion to their size, than those on plateaus and low plains.

COMPOSITION OF THE EARTH.—There are about sixty-three elements which compose the land, air, and water. Eight of these make up the greater bulk, the others being found in comparatively small quantities.

OXYGEN.—Oxygen is an invisible gas, without odor or taste, which constitutes about $\frac{4.5}{100}$ by weight of the crust of the earth; about $\frac{8.9}{100}$ of the water, and about $\frac{23}{100}$ of the air. It is a very active gas, forming combinations with nearly all the other elements.

SILICON.—Silicon is a solid, never found free in nature, but always in combination with some of the other elements. It

occurs most abundantly combined with oxygen, as quartz, flint, and sand. It constitutes about $\frac{2.5}{100}$ of the crust of the earth.

ALUMINUM.—Aluminum is a light, tough metal, never found pure in nature. It is found most abundantly combined with oxygen and silicon in the old granite rocks, as feldspar; and it is the principal ingredient of the different kinds of clay. It constitutes about $\frac{9}{100}$ of the earth's crust.

IRON.—Iron is a tough, whitish metal which is seldom found pure in nature. In combination with oxygen and other elements it constitutes about $\frac{9}{100}$ of the earth's crust.

CALCIUM.—Calcium is a light, yellowish metal, always found combined with other elements. It forms the basis of limestone and gypsum, and is found in other minerals, constituting about $\frac{5}{100}$ of the earth's crust.

MAGNESIUM.—Magnesium is a silver-white metal, which burns readily with a brilliant flame. It always occurs in combination with other elements, most commonly with oxygen and silicon, as talc, steatite, and meerschaum. It is also found in some limestone rocks and in sea-water.

SODIUM.—Sodium is a soft, white metal, never found pure in nature. It is best known in its compounds, with oxygen as soda, and with chlorine as common salt.

POTASSIUM.—Potassium is a soft, white metal which takes fire when thrown upon water; always found in combination with other elements; and best known in the compounds potassa, saltpetre, etc. It is also found in the old granite rocks. Magnesium, sodium, and potassium each constitute about $\frac{2}{100}$ of the earth's crust.

CARBON.—Carbon is a solid, found nearly pure in the diamond. Its most interesting compound is carbonic acid, a

union of carbon and oxygen, which is found free in the air, and in combination in limestone and other rocks.

NITROGEN.—Nitrogen is a gas without color, taste or odor. It is found mixed with oxygen in the air, of which it constitutes about $\frac{77}{100}$ by weight. It makes but few combinations with other elements.

HYDROGEN.—Hydrogen is a gas having neither color, taste, nor odor. It is the lightest substance known except one. It is seldom found free in nature. It constitutes about $\frac{1}{8}$ by weight, of water, and is found in many other substances.

There are other interesting elements, some of which, as gold, silver, copper, zinc, etc., will be described in another place.

SOIL.—Portions of the crust composed of these and other elements, broken down, pulverized and intermingled by the action of heat, frost, air, and water, constitute soil.

NECESSARY CONDITIONS FOR PLANT LIFE.—The conditions necessary to plant life are air, water, soil, heat, and sunshine.

COMPOSITION OF PLANTS.—Plants are composed mainly of oxygen, carbon, hydrogen and nitrogen, which they get principally from the air and water. Plants contain also small quantities of potassa, soda, silicon, iron, lime, etc., which they obtain from the soil. Water not only serves as food for plants, but it dissolves the materials of the soil, which otherwise could not be appropriated by the plants.

From these materials, gathered from the air, water, and soil, the mysterious principle of plant life, with the aid of heat and sunshine, builds up all the various forms of the plant or vegetable world.

DISTRIBUTION OF PLANTS.—The amount of heat and rain-fall diminishes from the equator toward the poles, therefore the amount and character of plant life vary in the

same direction. Plants decrease in size and number of kinds from the equator toward the poles.

ISOTHERMAL ZONES.—The diminishing quantity of heat and rain-fall, and the varying character of the vegetation from the equator toward the poles, gives a basis for the division of the earth's surface into seven zones, bounded by isothermal lines, and called isothermal zones.

THE NORTH FRIGID ZONE.—This zone extends from the isotherm of 30° to the north pole. Its mean annual temperature is about 18° ; the annual rain-fall about 10 inches; winds mostly from the west and north-west, some from the east and north-east. In this zone there are vast tracts of land called *tundras*, which, while well supplied with moisture, owing to the extreme cold, produce but a scanty vegetation, such as mosses, lichens, ferns, grasses, and small shrubs. This vegetation, decaying, has formed the *peat bogs* of northern Europe and Asia. In the southern parts a few stunted pines, and, along the streams, alders and willows are found.

THE NORTH COLD TEMPERATE ZONE.—This zone is bounded by the isotherms of 40° and 30° . The mean annual temperature is about 35° ; the annual rain-fall is about 24 inches; the winds mostly from the west, some from the east and north-east. In this zone forests of narrow-leaved evergreens, as pine and spruce, prevail, with some deciduous trees, (those that drop their leaves in Autumn) and many acid berries, as the gooseberry cranberry, currant, etc.; great numbers of grasses, Indian rice. etc. In some parts the conditions are such that large tracts produce only grasses and small shrubs. Such tracts are called *steppes*, and are very extensive in North America, as well as in Europe and Asia.

THE NORTH TEMPERATE ZONE.—This zone is bounded by the isotherms of 40° and 60° . The mean annual temperature is about 50° ; the annual rain-fall about 36 inches; winds mostly south-west and westerly, a few north-east and east.

In this zone forests of deciduous trees prevail; as, the oak, walnut, maple, birch, elm, etc., with some pine and spruce. In this zone there are also broad *steppes*, and broad tracts, called in America *prairies*, having a deep, rich soil, and producing a rank growth of grasses and herbs.

THE NORTH WARM TEMPERATE ZONE.— This zone is bounded by the isotherms of 72° and 60° . The mean annual temperature is about 66° ; the annual rain-fall about 58 inches; winds south-west and north-east. In this zone forests of broad-leaved evergreens; as, the laurel, oleander, and palmetto occur along with pine and deciduous trees. There are some *steppes* in this zone, and in America and Asia broad areas almost entirely devoid of vegetation, called *deserts*. These are caused by lack of moisture and great heat, by lack of moisture and great cold, or by a lack of soil.

THE TORRID ZONE.—The torrid zone is bounded by the isotherm of 72° , both north and south of the equator. The mean annual temperature is about 78° ; the annual rain-fall about 85 inches; winds north-east and south-east. In this zone dense forests of large trees occur, intertwined with parasitic plants, vines, etc. Palms, tree-ferns, coffee, indigo, bamboo, spices, etc., make up the characteristic vegetation. In this zone there are tracts of land, which during the wet season are covered with a rank vegetation of lilies, other bulbous plants, and grasses; but during the dry season the stems and leaves of these plants are burned up, so that the country seems a desert.

In Northern Africa is the Sahara Desert on which there is found no vegetation.

THE SOUTH WARM TEMPERATE ZONE.—This zone is bounded by the isotherms of 72° and 60° . The mean annual temperature is about 66° ; annual rain-fall about 35 inches; winds north-west and south-east. In this zone we find about the same vegetation as in the one north, except in Australia, where are found the eucalipti, grass-tree, zamia, etc.

In this zone there are broad steppes in South America, Africa, and Australia.

THE SOUTH TEMPERATE ZONE.—This zone includes the southern portion of South America and some islands, and is bounded by the isotherms of 40° and 60° . Vegetation rather scanty, and nothing peculiar.

CONDITIONS NECESSARY TO ANIMAL LIFE.—The conditions of animal life are air, water, plants, heat, and sunshine. Animals are composed of the same materials that plants are composed of, but the materials are a little differently combined. Animals can not assimilate these materials till they have been first assimilated by plants.

CLASSIFICATION OF ANIMALS.—Animals are *herbivorous*, or plant-eating; as, the buffalo, deer, horse, sheep, etc. Or they are *carnivorous*, or flesh-eating; as the lion, wolf, hyena, etc.

DISTRIBUTION OF ANIMALS.—Animals depend so largely upon plants for their existence, that their distribution corresponds to the distribution of plants; *i. e.*, animals decrease in size and number of kinds from the equator toward the poles. The reindeer, polar bear, and musk-ox are almost the only exceptions on the land, but in the ocean, whales, the largest animals known, are found in the polar regions.

DISTRIBUTION OF ANIMALS IN THE ZONES.—We find characteristic animals in each zone. In the frigid zone are found the polar bear, reindeer, seal, sable, and many other fur bearing animals, together with large numbers of swimming birds; as, ducks, geese, penguins, etc.

In the cold temperate zone, the moose, elk, deer, and beaver are found; in the temperate zone, the bear, buffalo, wild boar, tiger and panther; in the warm temperate zone, the gazelle, camel and leopard.

In the torrid zone are found, the sloth, ant-eater, alligator, monkey, the elephant, hippopotamus, rhinoceros, lion, tiger, dromedary, antelope, the baboon, ape, ostrich, and great numbers of birds with beautiful plumage.

In the warm temperate zone south, are found the alpaca, cougar, zebra, kangaroo, black swan, lyre-bird, etc.

VEGETATION AND ANIMALS OF NORTH AMERICA.—North America consists of an extensive plain with a lofty mountain system on the west, and low mountain ranges on the east. On the basis of moisture, the frigid, cold temperate, temperate, and warm temperate zones of North America, may be divided into an *eastern* and a *western* division by the 97th meridian. The eastern division has plenty of moisture, and each zone has its characteristic vegetation, except in the western part of the temperate zone where are found the prairies of America. The westerly winds lose so much of their moisture in crossing the Sierra Nevada and Cascade Mts. that the greater part of the western division has but little moisture. The characteristic vegetation is found in the frigid zone; the forests of the cold temperate zone are separated by broad steppes, while in the temperate and warm temperate zones the vegetation consists of a scanty growth of grasses, and shrubs on the plains, with scattering forests of narrow-leaved evergreens on the mountains, and along the streams, the plum, cotton-wood, etc. On the narrow Pacific Slope there is abundant rainfall and a dense growth of pine, spruce, cedar, etc. In the *torrid zone*, along the coast, are found mahogany, logwood, ebony, tree-fern, etc.; on the slopes, the vegetation of the temperate zone; on the plateau, the vegetation of the cold temperate zone, with broad steppes and barren tracts.

Peculiar Vegetation of North America.—Indian rice, red-wood, cotton-wood, tulip tree, live-oak, logwood, cactus, etc.

Peculiar Animals of North America.—Musk-ox, grizzly bear, Rocky Mountain sheep, raccoon, opossum, turkey, etc.

VEGETATION AND ANIMALS OF SOUTH AMERICA.—The greater portion of South America lies in the torrid zone. The moist, easterly winds of this zone supply the country east of the Andes with an abundant rain-fall, and the vegetation is also abundant. In the north are forests of the various kinds of palms, satin-wood, rose-wood, etc.; plateaus, which are *deserts* in the dry season, but covered with a luxuriant vegetation during the wet season; and, along the coasts and rivers, vast marshes. Along the Amazon river is a broad belt of dense forests intertwined with gigantic vines and flowering parasitic plants; and on the plateau of Brazil are fine forests of useful trees. Farther south, the north-westerly winds, losing their moisture in crossing the Andes, reach the La Plata Valley as dry winds, consequently there is scanty rain-fall and vegetation in this region, the vegetation consisting mainly of coarse grasses, thistles, and shrubs. In the south is the scanty vegetation of the cold temperate zone. West of the Andes, in the temperate and warm temperate zones, there is plenty of moisture and abundant vegetation. In the torrid zone the easterly winds have lost their moisture, the country is dry, and the vegetation scanty.

South America is characterized by its forests of large flowering trees, and by its great number of beautiful birds and insects.

Peculiar Vegetation of South America.—Brazil-wood, green-heart, the cow-tree, satin-wood, pine-apple, vanilla, cayenne pepper, etc.

Peculiar Animals of South America.—Armadillo, long-tailed monkeys, sloth, condor, toucan and many kinds of humming-birds.

VEGETATION AND ANIMALS OF EUROPE.—Europe lies for the most part in the cold temperate, temperate, and warm temperate zones. Owing to the influence of the Gulf Stream and the south-west winds, these zones are in higher latitudes in

Europe than in North America ; and for the same reason the climate of Europe is warmer and more moist in the western than in the eastern part ; the *surface* of Europe also modifies its climate to some extent, the south-west third being mountainous ; the eastern and northern two thirds being a low plain. In the cold temperate zone are *tundras*, and extensive forests of narrow-leaved evergreens ; as, pine, spruce, and larch ; and in the western part of the temperate zone, deciduous trees, with broad areas of cold temperate vegetation among the mountains ; in the eastern parts the forests are separated by broad steppes. In the warm temperate zone, the broad-leaved evergreens are found ; but the hot, parching winds from Africa, and the cold winds from the mountains prevent that rank, abundant growth of vegetation found in this zone in North America.

Peculiar Plants of Europe.—The cork-oak, lavender, mignonette, etc.

Peculiar Animals of Europe.—The chamois, ibex, auroch, etc.

THE VEGETATION AND ANIMALS OF ASIA.—Asia lies in the frigid, cold temperate, temperate, warm temperate, and torrid zones, and has the characteristic vegetation of each. Asia has broader plains and plateaus, higher and more extensive mountain systems, than any other grand division. The mountains shut off the moist winds of the Pacific and Indian Oceans from a large portion of the interior, so that large areas are barren from lack of rain-fall. The barren plains and plateaus, the mountains, the frigid and cold temperate zones, comprise more than half the area of Asia, and are covered with a scanty vegetation, or have none at all. It is only on limited areas bordering the Pacific and Indian Oceans that the conditions are favorable to an abundant vegetation. That portion of the temperate and warm temperate zones lying along the Pacific Ocean consists principally of a low plain, which receives plenty of moisture from the south-west and and north-east winds, and produces an abundant and varied

vegetation ; as, the tallow-tree, camphor-tree, orange, grape, rice, tea, poppy, etc. In the torrid zone, along the Indian Ocean, are plains and plateaus, which receive abundance of moisture from the south-west winds, and produce a rank vegetation ; as, teak, banyan, bamboo, gutta-percha, tropical fruits, spices, medicinal plants, etc. ; and in Arabia, coffee, aromatic plants, the mimosa, etc. The plateau of Iran, with its neighboring valleys, in the warm temperate zone, is the native place of the peach, apricot, almond, cherry, rose, and many other useful and interesting plants.

Animals.—Central Asia is probably the native place of the horse, ox, sheep, goat, hog, etc. ; and in Southern Asia are found the camel, ourang-outang, tiger, numerous species of the monkey and bat, and many birds of brilliant plumage. Thus we see that while so large a portion of Asia is unproductive, it still produces a large number of useful and interesting animals and plants—in fact, a larger number than any other grand division.

VEGETATION AND ANIMALS OF AUSTRALIA.—Australia lies wholly in the warm temperate zone, and consists mainly of low plains and a low plateau, with a few mountains in the south-east, which rise high enough to condense a little moisture, from the winds ; but Australia, as a whole, has less rain-fall than any other grand division, and is characterized by its scanty and peculiar animal and vegetable life. The eucalipti and other large flowering trees belonging to the *myrtle family*, the marsh-oak, a valuable timber tree, with long slender branches, and the accacias, (small shrubs with flattened leaf stalks in the place of leaves,) make up the greater part of the vegetation. The leaves of the trees hang with their edges upward so that they cast little shade. The epacris, and the proteas, (shrubs with dark green foliage and brilliantly colored flowers,) zamias, lilies, etc., are common in the south-east. In the southwest the grass-tree, and in the north the sandal-wood, mangrove, nutmeg, etc., are found ; yet a large portion of the area of Australia is a barren waste.

Animals.—The principal animals are the kangaroo, echidna, ornithorynchus, black swan, lyre-bird, bird of paradise, and other birds of beautiful plumage.

VEGETATION AND ANIMALS OF AFRICA.—Africa lies in the north warm temperate, torrid, south warm temperate, and temperate zones. It consists of a broad plateau surrounded by mountain chains, with narrow coast plains. The mountains deprive the winds of so much of their moisture that fully one-half of Africa has but scanty rainfall, and consequently a scanty vegetation, or none at all. On the coast the characteristic vegetation of the respective zones is found; in the interior, along the valley of the Nile, the deleb, doom, and wine palms; along the northern border, and on the oases of the Sahara, the date palm and coarse grasses are found; in the equatorial regions there is plenty of moisture, and vast areas of grasses, herbs and other plants, which make up the dense vegetation of swamps, occur; on the upland, the baobab, pandanus, butter-tree, tamarind, etc. On the southern plateaus, thorny shrubs and many species of flowering shrubs; as, the proteas and heaths, also euphorbias, geraniums, etc., and broad areas covered with a rank vegetation during the wet season, but having the appearance of deserts during the dry season. On the whole, the vegetation of Africa is scanty and somewhat peculiar, characterized by its numerous species of palms and flowering shrubs

The Animals are of the higher orders, and many of them are peculiar; as, the gnu, zebra, giraffe, gorilla, lion, ostrich, etc.

MAN.

HOW DISTINGUISHED FROM OTHER ANIMALS.

Man, as an animal, stands at the head of the animal kingdom :

First, by reason of his erect form.

Second, by reason of the perfection of his hand.

Third, by the freedom of the hand from use in locomotion.

As regards *intelligence*, the difference between man and other animals, seems to many, to be simply the possession of a higher degree of the *same kind* of intelligence ; but the difference is so great, that to many others, man seems to have a *different* kind of intelligence.

Man, by means of his superior consciousness, is enabled to see himself as capable of becoming something more than he is : the attempt to reach this ideal leads to self-improvement, which the animal, unaided, is not capable of.

But man's faculty for knowing GOD, and for knowing *right* from *wrong*, separates him entirely from the animal, and makes him a religious and a moral being.

LANGUAGE.—Language is a medium for conveying ideas from one intelligent being to another. Man and other animals have a *natural* language in common ; but man, by means of his superior intelligence, and through organs fitted to express such intelligence, is able to invent, and express an *arbitrary* language, through which he can clearly communicate his thoughts to his fellow man.

Language makes history possible, which enables one generation to profit by the successes or failures of former generations.

There are a great many languages in use among men, which, on the basis of *structure*, may be divided into *three classes*:

First, the *Monosyllabic* languages, which are spoken by the people of Eastern Asia.

Second, the *Agglutinative* languages, in which certain monosyllables are used together, yet, many of them retaining their own individuality. These languages are spoken by the natives of America, by many tribes in the north of Europe and Asia, and by tribes in Africa and in the islands of the Pacific and Indian Oceans.

Third, the *Inflectional* languages, in which the monosyllables, used together, often lose their identity, giving rise to a great number of grammatical forms.

In the inflectional languages, thought can be expressed more fully and clearly than in the others. They are spoken by the people of South-Western Asia, of Southern and Western Europe, and by their descendants in all parts of the world.

Of these languages, those spoken by the Europeans and their descendants are the most vigorous and important.

RELIGION.

Religion is belief in, and the worship of, a *superior being*. Wherever man is found, whether ignorant or intelligent, he has a belief in, and some form of worship of, a *superior being*; hence, *man* is called a *religious being*.

There are a great many *forms* of religion, differing from each other as the intelligence of man differs in various parts of the earth. Each of these forms has in it more of good than of evil, and is better than no form of religion.

The more important forms of religion are those of Confucius and Zoroaster; of Scandinavia, Egypt, Greece and Rome; of Brahmanism, Buddhism, Judaism, Mohammedanism, and Christianity.

That form of religion must be best which does the most toward developing the *good* there is in man, and toward repressing the *evil*. It should so completely meet his wants that it may become universal.

CONFUCIANISM.—That form of religion promulgated by Confucius about 2,400 years ago, in Eastern Asia, teaches pure morals, and a reverence for the deeds of ancestors, but gives no definite ideas of a future life; it does not awaken desires for improvement. Its followers are socially, morally, and mentally, where their ancestors were 2,000 years ago.

THE FORMS OF ZOROASTER AND SCANDINAVIA.—Those forms of religion taught by Zoroaster in Central Asia, and the one believed in Scandinavia, consider the world as divided between two kingdoms—the one of *Light*, the other of *Darkness*; that the former is the source of all *good*, the latter of all *evil*, and that the earth is the scene of a constant battle between the two kingdoms.

THE EGYPTIAN FORM OF RELIGION.—The Egyptians revered God as manifested in nature, believed in transmigration, in the sacredness of the human body, and in the sacredness of animals and plants, but did not recognize God as separate and distinct from nature.

THE GRECIAN FORM OF RELIGION.—The believers in this form of religion, idealized and worshipped the beautiful in nature, and the genius of man; but this form lacked unity, hence it lacked strength and influence.

THE ROMAN FORM OF RELIGION.—This form of religion recognized the the divinity of *Law* and *Justice*; but its intense formality seemed to retard, rather than promote the development of mankind.

BRAHMANISM.—Brahmanism is believed by about 80,000,000 of people in Southern Asia, teaches the existence of *spirit* as distinct from *matter*, the *infinite* as distinct from the *finite*; yet it does not explain, but denies the world; it does not aid man in practical life as did the Egyptian belief. It satisfies the dreamy, indolent peoples of Southern Asia, but fails to satisfy mankind as a whole.

BUDDHISM.—Buddhism is believed by nearly 300,000,000 of people in Southern and Eastern Asia. It teaches that man is responsible for his acts, and promises ultimate reward for good works and obedience to the truth, but it does not inspire faith in a living, present God, nor in a definite immortality. The principle of development, is therefore wanting; it restrains the evil in man, but does not foster the good.

JUDAISM.—The Jews believe in the God of the Old Testament, and in the Old Testament system of worship. Judaism teaches the unity of mankind, pure morals, and reverence for the past; that God, while everywhere present in nature, is still a *spirit* separate and distinct from nature. It inspires a love

for the beautiful and the noble; it recognizes the divine origin of law and justice; it teaches a system of rewards and punishments for the acts of man. In short, Judaism includes all the correct teachings of all the other forms of religion, seeming more fully to meet the wants of man than any of the others. It seemed fitted to become universal, but the extreme national pride of the Jews prevented them from making many proselytes. About 1875 years ago, from the teachings of their Scriptures, the Jews expected the Messiah to appear; but when a person appeared, called Jesus, or Christ, who claimed to be the Messiah, the Son of God, the main body of the Jews would not accept him. Those who did accept and believe him were called Christians, and their form of religion was called *Christianity*.

CHRISTIANITY.—Christianity includes all the good of Judaism, and adds to it a clearer comprehension of the *brotherhood* of man, and aims to carry out the injunction of Christ, “Go ye into *every nation* and preach the gospel to *every creature*.”

MOHAMMEDANISM.—About 600 years after Christ, Mohammed proclaimed a new form of religion, in South-Western Asia, accepting the essential truths of Judaism, recognizing the prophets of the Jews and Christ as true prophets, but announcing himself as the greatest prophet of all. As Mohammed increased in power and influence, he began to degenerate in character, and Mohammedanism degenerated also; yet, by the help of the sword, it made many converts, and many still believe in Mohammedanism. This form of religion does not seem to elevate mankind.

In 1054, contentions arising between the Bishops of Rome and Constantinople, a division of Christianity into two branches occurred. One, the *Greek Catholic*, has its head in the Patriarch of Constantinople, and is accepted by a large number of people in Eastern Europe and South-Western Asia. They deny infallibility to man, do not believe in purgatory, do not grant indulgences. The other, the *Roman Catholic*, having

its head in the Pope of Rome, is accepted by the people of South-Western Europe, and by a portion of those in the central part, and by large numbers in all parts of the world. They believe in the infallibility of the Pope, do believe in purgatory, and do grant indulgences.

PROTESTANTISM.—During the first of the sixteenth century, under the leadership of Luther and others, Protestantism commenced as an offshoot from the Roman Catholic Church. Protestantism claims to be a purer form of Christianity than either Roman or Greek Catholicism. Christianity, in some form, is accepted by the more intelligent and powerful peoples of the earth. It seems adapted to all sorts and conditions of men. Wherever it finds man it elevates and ennobles him. Christianity seems best fitted to be the universal form of religion.

There are many other forms of religion accepted in different parts of the earth; but if the Christian idea of God is the true one, the universal belief in a supreme being, must be a belief in the God of Christianity; and all the good in the different forms of religion must be derived from the same source.

The so-called idolatrous or Pagan religions doubtless are degenerations from purer forms, through the use of material objects to aid in gaining an idea of the spiritual, until the spiritual is lost and the material alone remains.

NUMBER AND RACES.

There are about 1,391,000,000 of people on the earth, of which Asia contains 768,000,000; Europe, 300,500,000; North and South America, 84,500,000; Africa, 203,000,000; Australia and the Islands of the Pacific, and Indian Oceans, 4,500,000.

RACES.—It is generally supposed that all the people of the earth are descendants of *one family*; although in different parts of the earth they vary greatly in form, color, language, intelligence, and religion. These variations probably arise from climate and other external causes.

On the basis of one or more of these differences the attempt has been made to divide mankind into *Races*. Several divisions have been made; but while no classification yet made is entirely satisfactory, still some division seems necessary for convenience.

A division into *five* races, on the basis of physical characteristics, is most common.

FIRST, THE INDO-EUROPEAN.—The members of this race have a white or light complexion, and straight or curled hair of various colors. They are found in Southern and South-Western Asia, in Northern Africa, in Central and Southern Europe. A large number of their descendants are found in America and Australia.

SECOND, THE MONGOLIAN.—The members of this race have a yellow complexion, coarse, straight, black hair, and a short, broad form. They are found in Eastern and Northern Asia, and in the northern parts of Europe and North America.

THIRD, THE AMERICAN RACE.—The members of this race have a red complexion, coarse, straight, black hair, and a tall, shapely form. They comprise the greater portion of the native inhabitants of America.

FOURTH, THE MALAY RACE.—The members of this race have a brown complexion, black, straight or curled hair, and are well formed. They are found in South-Eastern Asia and on the islands of the Pacific and Indian Oceans.

FIFTH, THE AFRICAN RACE.—The members of this race have a black complexion, closely curled, black hair, and often an ungainly form. They are found principally in Africa. Some of their descendents are found in Europe and America.

The Indo-European Race use the inflectional languages; a portion of the Mongolian in Eastern Asia uses the monosyllabic languages, the others use the agglutinative languages.

Of these Races, the Indo-European is the most intelligent and powerful, and is the best known.

On the basis of *language*, this race is divided into two families; the *Semitic* and *Aryan*, and perhaps a third, the *Hamitic*. The Hamitic family is now extinct, but has left monuments of its existence and intelligence in the ruins of Egypt and Assyria. They were a highly cultured people, living in cities, while the Semitic and Aryan were still roving tribes, living in tents. They understood architecture, sculpture, picture-writing, navigation, and something of astronomy, chemistry, and other sciences.

The Hamitic family seems to have been intimately related to the Aryan and Semitic, but whether it was a family from which they had their origin, or whether it was a branch with them of some still earlier family, is not known.

The *Semitic Family* has been divided into three branches: the *Aramæans*, *Arabians*, and *Hebrews*. The Aramæans occupied Assyria on the breaking up of the Hamitic family.

The *Arabians* occupy the peninsula of Arabia and portions of Northern Africa.

The *Hebrews* occupy that part of south-western Asia along the Mediterranean Sea, and are found scattered through all parts of the world.

Through the Semitic family we have received the higher forms of religion, Judaism and Christianity, the alphabet, commerce, and many interesting facts in science.

The *Aryan Family* has been divided into seven branches, as follows:

ARYAN FAMILY.	Ancient Germans.	Germans. English. Danes. Swedes. Norwegians. Dutch.	} Germanic Nations
	Anc't Slavonians	Russians. Poles.	} Slavonic Nations.
	Ancient Romans.	French. Italians. Spaniards. Portugese.	} Romanic Nations.
	Ancient Greeks.	Modern Greeks,	Greeks.
	Ancient Kelts.	Irish. Highland Scots. Welsh. People of Brit- tany in France.	} Kelts.
	Ancient Persians.	Persians.	Persians.
	Ancient Hindoos.	Hindoos.	Hindoos.

The Aryan family once occupied the valleys of the Hindoo Koosh mountains in central Asia, sending out colonies at different times. The Kelts and Slavonians toward the north-west; the Germans, Greeks, and Romans toward the west and south-west; the Hindoos toward the south-east, while the Persians occupy the same region occupied by their ancestors many years ago.

We know that these different people have the same origin from the great number of words which are common to the languages of all. The common words also give us a brief history of the ancient family. Their name signifies that they were an agricultural people; they made roads, built ships, erected houses, made cloth, had cattle, horses, sheep, swine, dogs, etc., and had a knowledge of most of the useful metals; the family relation was respected, and they had settled forms of religion and government.

The European branches of this family, including their descendants, are the most intelligent and powerful people of the present time.

Wherever the Aryans went they found wandering tribes which were called *Turanians*, including all people speaking agglutinative languages.

Mankind on the basis of language has been divided into the Semitic, Aryan, and Turanian Races, with many subdivisions.

The characteristics of the different races will be more fully discussed in the study of the grand divisions.

INDUSTRIES.

At first man's physical wants were supplied by the spontaneous productions of nature. Berries, wild fruits, and roots furnished food; leaves, bark, caves, etc. furnished clothing and shelter.

At length different kinds of wild animals and fish were found to be useful, giving rise to the industries of *hunting* and *fishing*. As these spontaneous productions began to fail, man commenced to aid nature in producing the things he needed, giving rise to the industries of *agriculture* and *stock raising*. Man soon found that the earth contained substances which, for some purposes, might be made more useful to him than any animal or vegetable substances, hence the *mining* industry.

Preparing for use the materials furnished by nature gave rise to *manufacturing*.

Exchanging the products of one locality for those of another gave rise to *commerce*.

Man has certain rights, and as mankind increased in numbers, *governments* became necessary to define these rights and to make and execute laws for their protection.

SPONTANEOUS PRODUCTIONS.

These consist of the various kinds of *berries*: as, raspberries, cranberries, blackberries, etc.; *wild fruits*, as, plums, cherries, bananas, dates, bread fruit, peaches, apples, apricots, etc.; *edible roots*, as the sweet potato, yam, manioc, etc.; *grains*; as, the Indian rice, of north America, and the true rice of Asia, maize, millet, etc.

In North America there are nearly one hundred plants whose fruit, stems, or roots are used as food by the natives. The other grand divisions furnish a proportional number. This shows that the spontaneous productions of the earth would support quite a large population.

HUNTING.—*Hunting* is the pursuit of wild animals for the purpose of catching or killing them. Animals are hunted for the food they furnish, or for their skins and fur, or for both reasons; sometimes for the purpose of destroying those that are noxious, and sometimes for recreation and sport.

Those animals hunted chiefly for their flesh are birds; as, the duck, goose, snipe, plover, woodcock, grouse, quail, pigeon, turkey, etc. Those for their skins and fur alone, are the beaver, mink, sable, fox, ermine, wolf, etc. Those hunted for both their flesh and skins are the buffalo, antelope, seal, reindeer, bear, deer, moose, elk, sheep, squirrel, and many others.

Animals whose flesh or skins are useful to man are found abundantly in all parts of the earth.

DOMESTIC ANIMALS AND HERDING.—Other animals were tamed and cultivated by man; some useful to him for their flesh and skins, some for their strength and intelligence, some not only furnishing flesh and skins, but aiding him with their strength and intelligence as well.

These are the *domestic animals*; as, the horse, ox, sheep, hog, camel, elephant, reindeer, and dog; also many fowls.

The cultivation of domestic animals is called *herding* or *stock-raising*.

THE HORSE.—The horse, highly prized by man for his strength and intelligence, is a native of Asia. Vast herds of wild horses are still found on the dry steppes of Europe and Asia. The form of their lips and teeth allows them to crop the scanty herbage of these plains. The horse should be kept on dry pasture ground, or in roomy, well lighted, well ventilated stables, with hay, and oats or corn for food. There are many varieties of the horse, arising from difference in climate, care, and character of work performed. The finest varieties are found in South-Western Asia, in Europe, and in North America.

THE CAMEL.—The camel seems especially fitted to serve as a beast of burden on the deserts of the torrid, and warm temperate zones. The feet seem adapted to the loose, hot sand of the desert; the humps of fat on its back often are the main supply of food for long journeys, and the structure of its stomach enables it to drink water enough at one time to last for several days. It has been named the *the ship of the desert*, and is invaluable to the inhabitants of desert countries.

The camel and elephant are the principal beasts of burden in the torrid zone; the horse in the warm temperate, and temperate zones, while the dog and reindeer are used for that purpose in the cold temperate, and frigid zones. The flesh and milk of the reindeer are valuable as food, and the skins of all are more or less useful.

THE SHEEP.—The sheep, found mainly in the temperate zones, is a native of Asia, and valuable as it furnishes materials for food and clothing. The sheep delights in dry pasture grounds, being adapted to the same climate and soil as the

horse. The flesh of the sheep is largely used for food; and from its wool excellent material for clothing is made. The finest wools come from Saxony, France, and Spain. The wool produced in the United States in 1870 was valued at about \$40,000,000.

THE HOG.—The hog is a native of Asia, and is chiefly valuable for its flesh, which is extensively used as an article of food. The hog is raised in great numbers in all parts of Europe and the United States.

FOWLS.—The different fowls, such as the turkey, hen, duck, goose, etc. are valuable mainly for their flesh, although their feathers are of some importance, especially those of the goose.

THE OX.—But the most important of all the domestic animals is the ox, a native of Europe and Asia. The ox is valuable for its skin, flesh, and milk; the male is also extensively used as a beast of burden in the temperate zone.

The ox does not thrive on the scanty herbage of the dry plains as does the horse and sheep, but delights in the rank vegetation of the moist pasture grounds. In stormy weather the ox should be sheltered in warm, well ventilated stables. Hay, corn, turnips, etc. are relished as food by the ox.

Great attention should be paid to the care and food of the ox, for on these depend to a great extent the health of the animal, and the healthfulness of its flesh and milk. Europe raises the finest varieties of the ox; America the greatest numbers.

DAIRY PRODUCTS.—Dairy products consist of milk, and the butter and cheese made from it.

Milk is a whitish fluid secreted by the female mammal for the support of its young.

In 100 parts of milk there are, of	{	Water,	88.0
		Sugar,	5.0
		Oil,	3.5
		Caseine,	3.0
		Salts,	.5

The quantity of these ingredients varies in the milk of different animals, and in the milk of the same animal under different conditions, as to health, food, etc.

The *caseine* of the milk, coagulated by rennet (an acid taken from the calf's stomach,) salted, drained, and pressed is *cheese*.

The *oil*, separated from the other ingredients, by violent agitation, and salted, is *butter*. These are important and extensive products throughout the north temperate zone. The dairy products of the United States for 1870, were valued at about \$180,000,000.

FISHING.

The *catching of fish* is a very important industry. The following are the most important fish caught:

HERRING.—The herring ranks first in importance. It is from six to fifteen inches long, and lives in cold salt water, coming into the shallow water to spawn. It is quite prolific, so that while immense quantities are caught, the number does not decrease from year to year. The herring fisheries are carried on, on both shores of the Atlantic Ocean, giving employment to more than 200,000 persons.

THE COD-FISH.—The cod rivals the herring in importance. It lives in cold salt water, sometimes attaining a weight of thirty or forty pounds. It is found on rocky or sandy bottoms at a depth of from fifteen to twenty-five fathoms. The cod occurs most abundantly on the coast of Newfoundland, though it is found on both coasts of the Atlantic and Pacific.

THE MACKEREL.—The mackerel is also found in cold salt water, and is abundant on both shores of the Atlantic Ocean. It is from twelve to twenty inches long, and weighs from two to three pounds. It comes into the shallow coast waters to spawn.

THE SHAD.—The shad is a native of cool salt water, and goes up the rivers to spawn. It attains a length of two or three feet, and weighs from four to twelve pounds. It is found in the coast waters, and in the rivers flowing in to the Atlantic Ocean.

THE SARDINE.—The sardine belongs to the herring family, and is found most abundantly in the warm waters of the Mediterranean Sea. Sardines are cleaned, dried, and packed in oil for commerce.

THE SALMON.—The salmon is a native of cold salt water, and goes up the rivers to spawn. It attains a weight of from twenty to thirty pounds. It is caught from the rivers flowing into the Atlantic and Pacific Oceans; but most abundantly from the Columbia River, in the western part of the United States.

THE WHITE-FISH.—The white-fish, found principally in the waters of the St. Lawrence River system, is very highly esteemed as an article of food. It belongs to the salmon family.

THE TROUT.—The different species of trout also belong to the salmon family. Those found in the Great Lakes sometimes attain a weight of from twenty-five to thirty pounds. The little speckled trout of the mountain brooks is highly esteemed as an article of food.

THE STURGEON.—The sturgeon is found in both salt and fresh water; those living in salt water go up the rivers to spawn. There are a great many species of the sturgeon found in the lakes, rivers, and coast waters of North America, Europe, and Asia. In the Caspian Sea it is especially abundant, where it sometimes has a length of twenty-five or thirty feet, and a weight of 2,000 or 3,000 pounds. It has no scales, but is covered with a great number of bony plates.

The pickerel, sucker, mullet, bass, cat-fish, and many others are found in fresh water. The pilchard, tuny, anchovy, hake, haddock, halibut, etc., are important fish from the salt water. Fish are cleaned, salted, and dried or packed for market.

THE WHALE.—The whale is not a fish, but the pursuit of the whale is called *whale fishing*. The whale is not caught for food, but for the oil and bone which it furnishes. It is found most abundantly in the *polar regions*, and is the largest animal known, often attaining a length of seventy or eighty feet. The whale has no teeth, but bones are arranged along the sides of his mouth so as to form a *sieve*, by which he strains from the water the little animals which constitute his food.

The catching of lobsters, oysters, clams, mussels and other mollusks or shell-fish, comes under the head of *fishing*.

LOBSTERS AND OYSTERS are taken in great quantities on both coasts of the Atlantic, and some are taken from the Pacific. Crabs, mussels, shrimps, etc., are caught and used more extensively in Europe than in America.

The importance of the *fishing industry* is shown by the fact that no less than half a million persons are actively engaged in it.

AGRICULTURE.

Agriculture is the cultivation of the soil for the purpose of raising useful plants. Plants are useful as they furnish food for man and animals, or as they furnish materials for man's clothing or shelter. Plants are useful for food, as they furnish *starch*, *gluten*, *sugar*, or *oil*.

KINDS OF SOIL.—There are several kinds of soil; as, *alluvial soil*, composed of sediment from running water; *heavy clay soil*, composed of clay, 75 to 90, sand, 10 to 25 parts; *loamy soil*, composed of clay, 40 to 60, sand, 40 to 60 parts; *light sandy soil*, composed of clay, etc., 10 to 25, sand, 75 to 90 parts.

Sand is sometimes mixed with clay soils so that they may be more easily worked, and clay mixed with sandy soils to make them more tenacious.

FERTILIZERS.—Soil often lacks the materials which the plant needs; these may be supplied by *manures* or *fertilizers*. The following are the most common fertilizers:

ANIMAL EXCREMENTS.—Animal excrements are used everywhere as manures. Guano, the excrement of fish-eating birds, is the most valuable. These furnish nitrogen, potassa, lime, etc., to the growing plant.

Common lime, pulverized, *burned bones*, *shell* and *bog lime* from swamps and marshes are used principally for the lime they furnish the plant.

Muck or *peat*, (partially decayed vegetation,) *ashes* of plants *saltpetre*, (often found in caves,) unpurified *sea-salt*, and many other substances are used as fertilizers.

The following are the most important of the cultivated plants:

GRASS AND HAY.—There are about 4000 kinds of grasses, which together constitute the *Grass Family*, which is a very important family to man. In any climate from the equator to the polar snows, in any soil from the water covered marsh to the dry sandy plateau, some member of this family may be found.

Nearly all the varieties are relished as food by some of the plant-eating animals. The stems and leaves of grasses cut and dried as food for animals, are called *hay*. Those grasses commonly cultivated for hay, grow best on a clayey soil, in a moist, cool temperate climate. Most of the hay is cut between the isotherms of 50° and 40° north. The United States in 1870 produced 27,000,000 tons of hay, which at \$12 per ton, amounts to \$324,000,000. During a portion of the year, the cattle, horses, sheep, etc. live on wild or cultivated grasses, hence a portion of their value should be added to the value of the hay crop. One-eighth of the value of all live stock and slaughtered animals, (\$240,000,000,) and two-thirds of the value of dairy products, and wool, (\$140,000,000,) added to the value of the hay crop, (\$324,000,000,) makes a total of \$704,000,000, as the value of the grass crop of the United States in 1870.

RICE.—Rice is a member of the *grass family*, and is a native of Southern Asia. It is a water plant, growing best in alluvial, clayey soil, and in a hot, moist climate. For the greater part of the growing season the ground should be covered with fresh water. It is cultivated extensively in Southern and Eastern Asia, and to some extent in the other grand divisions. It grows only in the warm temperate and torrid zones.

In 100 parts of rice there are, of	{	Starch,	85.0
		Water,	5.0
		Gluten, etc.,	3.6
		Veg. Fibre,	4.8
		Ash, oil, etc.,	1.6

Rice is perhaps the most useful grain, as it furnishes the principal food for nearly one-third of the human family.

WHEAT.—Wheat is also a member of the *grass family*. It is supposed to be native in Central Asia, and its cultivation is older than history.

Wheat will grow in a wide range of climate, and in a great variety of soils; but does best in a well-drained clay soil, and in a cool temperate climate, not too moist. It is cultivated most extensively between isotherms 55° and 45° .

In 100 parts of wheat there are, of	{	Starch,	46.0
		Gluten, etc.,	19.0
		Water,	15.0
		Veg. fibre,	13.0
		Sugar, oil, & ash,	4.7
		Albumen & gum,	2.3

Gluten is called *muscle forming food*. Wheat is very useful for food, and it is extensively raised. In 1870 the United States produced 287,000,000 of bushels. The United States, and the southern portion of Russia in Europe are the only countries that raise much wheat to export.

ENEMIES OF WHEAT.—Rust and smut, (vegetable growths) and the Hessian fly, wheat fly, corn moth, wire worm, etc, are the principal enemies of wheat.

BARLEY.—Barley is a member of the *grass family*, and probably a native of Central Asia. It has a wider range of climate than any other grain, but does best in a cool, dry climate, between isotherms 40° and 46° .

Soil, should be loamy or clayey, mingled with muck, or some animal excrement.

It is cultivated most extensively in Europe, in the northern parts of the United States, and in Canada. It is used as food

for man and animals, and for beer. In 1870 the United States produced 30,000,000 of bushels.

In 100 parts of Barley there are, of	{ Starch,	54.8
	{ Water,	14.2
	{ Veg. fibre,	11.4
	{ Gluten, etc.,	11.0
	{ Gum & sugar,	3.4
	{ Fat and ash,	5.2

Barley is said to be good *brain food*, on account of the phosphate of lime in the ash.

RYE.—Rye is also a member of the *grass family*, and probably a native of Central Asia. Rye does best in a sandy soil, and in the same temperature as that adapted to wheat, but will ripen in a climate too cold for wheat. Rye is a very important crop in Eastern Europe, as it will grow on very poor soil. It is used largely as food for man and animals and from it large quantities of whisky are manufactured.

In 100 parts of Rye there are, of	{ Starch,	57.0
	{ Gluten, etc.,	11.0
	{ Water,	16.0
	{ Gum, sugar, & oil,	8.0
	{ Ash and fibre,	8.0

OATS.—Oats also belong to the *grass family*. They need a cool, moist climate, and a strong clay soil, with some vegetable mould or muck. They are used as food for man in Scotland, where the best quality is raised; but the grain and straw are both mainly used as food for horses. They grow well in the region in which wheat is found, but will thrive in a little colder climate.

In 100 parts of oats there are, of	{ Starch,	53. to 65.2
	{ Gluten, etc.,	11.5
	{ Fat,	6.3
	{ Gum & sugar,	2.5
	{ Water,	13.3
	{ Ash and fibre,	1.2

In 1870 the United States produced 282 millions of bushels of oats.

MAIZE OR INDIAN CORN.—Maize is a kind of grass, a native of the warmer parts of America. There are a great many varieties arising from difference of climate and soil. It does best in a rich, stimulating soil, with hot sunshine and frequent showers. The most and best corn is grown between the isotherms of 45° and 60° north. The stalks are used as fodder for cattle, and the grain is used extensively as food for man and domestic animals.

In 100 parts of corn there are, of	{	Starch,	80.0
		Fat,	7.0
		Gluten, etc.,	6.0
		Ash, water, etc.,	7.0

It rivals wheat and rice in importance.

In 1870 the United States produced 761 millions of bushels of corn.

SUGAR CANE.—Sugar cane is also a kind of grass, a native of the East Indies, but now cultivated in each of the grand divisions. It does best on rich, moist, alluvial soils, in a hot, moist climate.

Sugar cane is usually propagated by cuttings; the top joints are cut off and planted for this purpose. On good soils it sometimes attains a height of 20 feet. It is ready for harvesting in from ten to twenty months after planting. It is cultivated between the isotherms of 65° north and south of the equator. Sorghum, a variety of sugar cane, will do well, in rich soils, as far north as the isotherm of 45° .

The greater portion of the sugar of commerce is made from the juice of the sugar cane. East India, the West India Islands, and the United States produce most of the cane sugar. In 1870, the United States produced 87,000 hhds.

In Europe sugar is made extensively from the *sugar beet*, and in America large quantities are made from the *sugar maple*.

BUCKWHEAT.—Buckwheat is a native of Central Asia. It will ripen as far north as isotherm 38° , and will do well on very poor soils. It comes to maturity in about three months after sowing, and is extensively raised in Europe, Asia and North America, in the northern part of the temperate zone. It furnishes good food for man and beast, and is sometimes used in making beer and gin.

In 100 parts of buckwheat there are, of	{	Starch, 52.to 68.0
		Gluten, etc., 10.0
		Gum, sugar, 6.0
		Water, 13.0
		Ash, etc., 3.0

Buckwheat is often sown, and after it is partly grown, ploughed under, as a fertilizer for some other crop.

THE POTATO.—The potato is a member of *potato family*, and a native of the mountainous regions of tropical America; yet it will grow in almost any climate or soil. It does best in light sandy soil, which contains a little lime, and some vegetable mould, temperature from 45° to 60° with a moderate rain-fall, but no heavy storms. In 1870 the United States produced 143,500,000 bushels of potatoes.

In 100 parts of potato there are, of	{	Water, 76.0
		Starch, 15.0
		Gluten, etc., 2.0
		Gum and sugar, 3.0
		Ash and fibre, 4.0

It is extensively used as food for man and domestic animals, although it is not very nutritious; one pound of wheat containing nearly six times as much nutriment, as one pound of potatoes.

TOBACCO.—Tobacco belongs to the *potato family*, and is a native of America. It is cultivated and used extensively in each of the grand divisions. It does best on a sandy loam, well fertilized with ashes, or guano; and in a temperature of about 60° , with light showers. From 19 to 27 per cent. of the tobacco leaf is ash, composed mainly of potassa, lime, and silica. One ton of tobacco takes from the soil, as much material as, ten tons of wheat, oats, or corn. It is an important article of commerce, the yearly export from the United States sometimes amounting to \$30,000,000.

COTTON.—Cotton belongs to the *mallow family*, and is a native of both continents, between the isotherms of 60° north and south. There are many varieties, probably arising from differences in climate, soil, and cultivation. The sea island cotton is a shrubby plant, from four to six feet high, and is the variety which furnishes the best cotton fibre; the green-seed, or upland cotton, which attains a height of ten or fifteen feet, and another variety, still larger, a native of China, are all cultivated extensively in America and Asia. The soil should be composed largely of sand, (about 90 per cent.) with some clay, lime, iron, potassa, etc. It needs hot sunshine, moist air and heavy dews. The seed is usually planted in March, the plant blooms in June, and the cotton is ready for picking in August or September. The United States produces more cotton than any other country; the product of 1870 was about 3,000,000 bales, weighing about 400 pounds each.

FLAX.—Flax is perhaps of more importance than cotton. From the earliest history of man, its fibre has furnished materials for clothing, and from its seeds a very useful oil, called linseed oil, is obtained. It is a native of Southern Asia, but it has a wide range of climate, thriving well between the isotherms of 72° and 38° North Latitude. It is extensively cultivated in Europe, and to some extent in Asia and America. It needs a rich soil and careful cultivation.

HEMP.—Hemp is also cultivated for its fibre, which is not quite so fine as that of flax. It has the same nativity and wide range of climate that flax has, and is cultivated extensively in Europe and America.

The different grains vary in quality with the character of the soil, climate, and mode of cultivation. The composition varies as the quality, but the figures given show the average proportion in which the different ingredients occur.

OTHER VEGETABLE PRODUCTS.—Peas, beans, hops, grapes, the mulberry, for the food of the silk worm, sweet potato, yam, banana, bread-fruit, date-palm, etc., are important vegetable productions.

The tea plant, a native of Asia, coffee, native to Arabia and Abyssinia, pepper, nutmegs, cloves, cinnamon, and other spices, natives of Asia and the adjacent islands, are all useful productions. There is also a large number of useful oils which are the products of plants; as, olive oil, castor oil, linseed oil, etc.; also the useful gums, and resins; as, tragacanth, gum acacia, myrrh, India copal, India-rubber, gutta-percha, etc., are vegetable products; and many plants yield valuable medicines, as, the poppy, cinchona tree, rhubarb, mandrake, etc.

MARKET GARDEN PRODUCTS.—Market garden products, as lettuce, radish, asparagus, pie-plant, cucumbers, various kinds of berries, celery, etc., are important productions. They will not bear long transportation, and are raised most extensively near large cities. Over twenty million dollars worth of these products were raised in the United States in 1870. They all need a well cultivated, loamy soil, and a temperature of from 45° to 65°.

ORCHARD PRODUCTS.—Orchard products, including the apple, pear, and peach, are of considerable importance.

The apple is supposed to have been obtained by a careful cultivation of the wild crab, a native of Central Europe. It does best in the cooler parts of the temperate zone, on a stiff, well

drained, clay soil, which is well supplied with lime. The best qualities are found between isotherms 55° and 45° , but very good qualities are found between 40° and 70° .

The pear is also a native of Europe, and requires the same soil and climate as the apple, but it will not do well in so wide a range of climate.

The Peach is a native of Central Asia. It requires a light sandy soil, with a temperature of from 45° to 55° , modified by the presence of large bodies of water. Plums, and Cherries also are classed as orchard products. They all belong to the *rose family*.

In 1870 the United States produced nearly fifty million dollars worth of fruit.

FOREST PRODUCTS.—The forest furnishes materials which man is able to make useful in many ways. The most useful trees are, the pine, larch, cedar, ash, maple, oak, elm, teak, camphor tree, eucalipti, bamboo, mahogany, rose-wood, logwood, etc.

The forest products of the United States for 1870 were valued at about \$140,000,000,

DISTRIBUTION OF CULTIVATED PLANTS, ETC., IN THE ZONES.—In the southern part of the cold temperate zone, barley, buckwheat, rye, flax, potatoes, turnips, etc., will grow on good soils, and forests of good pine also occur.

In the northern half of the temperate zone, hay, barley, oats, rye, and potatoes grow in great quantities, and of excellent quality. Wheat does best in the central part of the zone, but grows in all parts, while corn does best in the southern two-thirds. In this zone orchard and market garden products are abundant; also, forests of useful deciduous trees, with a belt of valuable pine forests in the north. The more important and useful animals are also found most abundantly in this zone.

Tobacco thrives best along the border between the temperate and warm temperate zones; and in the warm temperate zone, we find cotton, rice, and sugar-cane cultivated extensively, with corn, sweet potatoes and many tropical fruits, and in the forests are found valuable trees; as, the pitch-pine, live-oak, cork-oak, etc.

In the torrid zone, coffee, date-palm, bread-fruit, yam, indigo, cinnamon, pepper and other spices are the principal cultivated plants; in the forests are found many valuable trees.

MINING.

Mining is the process of taking useful *rocks* and *metals* from the ground.

ROCKS.

The *rocks* are found in beds or layers, which are, as a rule, nearly horizontal, and often of great thickness. The most important rocks are coal, granite, sandstone, slate, limestone, marble, and salt.

COAL.—The formation of coal has been explained. (Page 28.) Coal is used for fuel, and is valuable in proportion to the amount of carbon and hydrogen it contains. *Anthracite* or *stone coal* is of a bright black color, has an irregular, curved fracture, is free from dust, and burns without flame or smoke.

In 100 parts of anthracite coal	{ Carbon,	90.0
there are, of	{ Hydrogen,	2.4
	{ Oxygen, ash, etc.,	7.6

Anthracite coal is found in England and other parts of Europe, but in the greatest quantity in the United States.

Bituminous coal has a dull black color, a plane fracture, burns with flame and smoke, and is very dusty.

In 100 parts of bituminous coal there are, of	{ Carbon,	65. to 80.0
	{ Hydrogen,	8. to 5.0
	{ Oxygen, ash, etc.	27. to 15.0

This is the average composition of numerous varieties. Coal is found abundantly in South-Eastern Asia, in Europe and North America, and to some extent in the southern grand divisions. The most extensive deposits are found in North America. In 1870 England mined 117,000,000 tons of coal, and the United States mined about 50,000,000 tons.

GRANITE.—Granite is composed of quartz, feldspar, and mica, in varying proportions. Those varieties containing a large proportion of quartz and feldspar, are excellent material for building purposes. It is a hard rock, and the difficulty of working it makes it very expensive, but this is counterbalanced by its great durability. Good qualities are found in Egypt, Europe, and in the United States; Maine and Massachusetts furnishing the best.

SANDSTONE.—Sandstone consists of grains of sand of various sizes, cemented together into rock. The sand is mainly pulverized quartz, from the old granite rocks. If the cement is good, the rock is very hard and valuable as a building stone; some varieties are worthless, as the grains are not well cemented together. Sandstone varies in color from white to a dark brown, owing to the presence of more or less iron in the cement. Sandstone is used extensively in building, and some varieties are used for ornamental work. Good qualities are found on each continent. The best qualities in this country are found in Ohio and New Jersey.

SLATE ROCK.—Slate is mainly composed of feldspar, from the old granite rocks, which has been pulverized, and subjected

to great heat and pressure. It is used as material for drawing slates, and for roofing. For roofing, it should be pure, should split easily into plates, should not absorb water, and should admit of being pierced for nailing. Good qualities are found in Europe and in America.

LIMESTONE.—Limestone, composed of lime and carbonic acid, is carbonate of lime. It has an irregular fracture, is easily cut with a knife, effervesces with an acid, and the fossil shells, etc., of which it is so largely composed, may often be seen in it. Limestone is found in each of the grand divisions. Some varieties make fine building stone. Joliet, Ill., Lockport, N.Y., and Montreal, Canada, furnish the best varieties in this country. Limestone, burned to drive off the carbonic acid, is the common lime used so largely as an ingredient of mortar and plaster; it is also used as a fertilizer, and as a disinfectant.

MARBLE.—Marble has the same composition as limestone but is more compact and uniform in texture. It is used for building, for statuary, and other ornamental work. The finest qualities are found in Italy, Greece, and their adjacent islands. Vermont furnishes a very fine quality.

SALT.—Salt is composed of sodium 60.7, and chlorine 39.3 parts. It is chloride of sodium. It is largely used as an article of food for man and animals, also for the preservation of meats, etc. It is found in every grand division, and is obtained from mines as a rock, and from sea-water, or the water of saline springs, by evaporation. The most extensive deposit known is in Poland, where there is a mine nearly 1800 feet deep, with an extent of 9,600 feet, (nearly two miles,) from east to west, and of 3600 feet from north to south.

METALS.

Metals are found mainly in veins or cracks in the rocks, which are seldom more than a few feet in width, and as a rule, nearly vertical. The most important metals are, iron, copper, gold, silver, lead, zinc, tin, and mercury. The metal is sometimes *pure* in the veins, when it is called *native*; as, native copper, or gold; sometimes two metals are combined, forming an *alloy*; but more frequently the metal is combined with some other substances, forming an *ore*; as, iron combined with oxygen forms oxide of iron, or in different proportions, forming magnetic iron ore; or lead combined with sulphur, forming the sulphide of lead ore, etc.

IRON.—Iron is always found as an ore. There are numerous ores of iron, but only a few are of much importance.

Magnetic iron ore.—From this ore is made the best quality of iron. It occurs in eight-sided, iron-black crystals, composed of iron 73 parts, and oxygen 27 parts. Large quantities of this ore are found in Sweden, in the Ural Mountains, in the region of Lake Superior, and in lesser quantities in many other localities.

Hematite iron ore.—This is one of the most abundant ores of iron, varying somewhat in composition and appearance. It is composed of from 60 to 70 parts iron and from 40 to 50 parts oxygen and other substances. It is the most abundant iron ore of the United States and Europe.

Carbonate of iron, or clay iron ore.—This is the most important ore of iron found in England, where it occurs along with the coal. It consists of carbonate of iron mixed with clay and other substances, containing about 36 parts of iron, carbonic acid 24 parts, other substances 40 parts.

Sulphide of iron.—Sulphide of iron, or iron pyrites, is a brittle, brassy yellow substance, often found in coal, sometimes in the form of cubical crystals. From it is made the sulphate of iron or green vitriol, sulphuric acid, etc., but it does not furnish a good quality of iron. Iron is perhaps the most useful metal, and has been used by man since his earliest history.

In 1870 the United States produced about \$13,000,000 worth of iron.

COPPER.—Copper is found in nature as an ore, an alloy, and as native copper. It is a tough, heavy metal, which is found widely distributed in nature, and has been used by man since the earliest time. Large quantities of native copper, and of copper alloyed with silver, are found near Lake Superior. Copper in some form, is found abundantly in each grand division.

In 1870 the United States produced \$5,000,000 worth of copper.

GOLD.—Gold is found mostly as native gold, or as an alloy, but sometimes it is so intimately mixed with other substances, that it is virtually an ore. Gold occurs in veins, or in the alluvial sands formed by the breaking down of the vein rock. Taking gold from the veins is called *lode* mining; taking it from the sands is called *placer* mining. Gold is found in each of the grand divisions, but most abundantly in the western part of North America, the eastern part of Europe, and in the south-eastern part of Australia.

In 1867 the United States produced about \$60,000,000 of gold; in 1870 only about \$22,000,000.

SILVER.—Silver occurs in nature as an ore, an alloy, and as native silver. The most abundant ores of silver are, the *sulphide of silver*, silver combined with sulphur, and *chloride of silver*, silver combined with chlorine. Silver is found most abundantly in Mexico, Peru, Spain, Austria, and to some extent in Africa and Asia. The annual yield of Mexico is about \$20,000,000. In 1870 the United States produced about

\$4,000,000 of silver. Gold and silver are both highly prized for their beauty and durability, and have been used by man since the earliest record.

LEAD.—Lead occurs as an ore, for the most part as the sulphide of lead, called galena, composed of lead 86 parts, and sulphur 14 parts. This ore usually has the form of leaden-grey, cubical crystals. It is found extensively in North America and Europe, and in limited quantities, in the other grand divisions.

ZINC.—Zinc is always found as an ore, most abundantly either as the *carbonate* of zinc, or as the *sulphide* of zinc. Zinc is a hard, bluish-white metal, extensively used in medicine and in the arts. Zinc alloyed with copper, is an ingredient of German silver, and one part of zinc with two parts of copper forms brass. It is also an ingredient of other useful alloys.

The sulphides of zinc, lead, copper, iron, and silver, along with gold and other substances, are often found together in the same ore.

TIN.—Tin usually occurs as an oxide of tin. It is a malleable, silver-white metal, somewhat crystalline in texture. It is not much affected by the action of the atmosphere, and is largely used as a preservative coating for iron; it is also an ingredient of many useful alloys; as, pewter, solder, bronze, and bell-metal. Tin is found most abundantly in England, Spain, Saxony, and Austria, countries of Europe, but is little found in the other grand divisions.

MERCURY.—The greater portion of the mercury of commerce is obtained from cinnabar, the sulphide of mercury. It is found in Spain, Austria, and California, in great quantities. Mercury is used extensively in separating gold and silver from other substances, and in making thermometers, barometers, etc., as silvering for mirrors, and in medicine.

REDUCTION OF ORES.—The pure metal is obtained from the ore mainly through the action of heat. Sometimes not only great heat is necessary to free the metal from impurities, but chemical agents must be used, as in the case of iron. But lead, or mercury are freed from their ores by a comparatively slight degree of heat.

MANUFACTURING.

Manufacturing is the preparing of agricultural, mineral and other products for the use of man.

There are many hundreds of manufactures carried on by man. The value of the annual products of different manufactures vary from a few dollars to many millions.

Some of the operations employ the labor of but one person with simple tools, others employ machinery driven by animal, wind, water, or steam-power, often giving employment to thousands of persons. The most important manufactures are those by means of which materials for the food, clothing, and shelter of man are prepared.

The wheat, barley, rye, corn, etc. must be ground into flour or meal. This was formerly done by hand, in a rude way, between stones or in a mortar; now, machinery driven by steam, water, or other power does it better, more rapidly, and cheaper.

In 1870 the value of the product of this industry in the United States was about \$500,000,000.

The wool, cotton, hemp, and flax must be cleaned, spun, and woven into cloth. The use of improved machinery has reduced the cost of weaving 60 per cent. within sixty years.

The product of the cotton and woolen manufactures of the United States in 1870 was valued at more than \$375,000,000. England manufactures nearly one-half of the cotton and woolen goods of the world, employing more than 500,000 persons in this industry. From the skins of animals the various kinds of *leather* are prepared. Making useful articles from leather and the different kinds of cloth are important and extensive industries.

IRON ORE must be melted, cast, remelted and cast, rolled or hammered into useful articles; as, agricultural implements, the various kinds of machinery, tools, etc.

England takes the lead in the manufacture of iron. Krupp's iron works at Essen, in Prussia, however are the most extensive in the world. The iron manufactured in the United States in 1870 was valued at about \$400,000,000.

Building material; as, timber, lumber, etc., manufactured from forest products in the United States in 1870, was valued at more than \$250,000,000. Also, large quantities of rock were dressed, and many millions of brick were made for building purposes.

There are many other extensive and interesting manufactures, but the above are the most important. Manufacturing adds much to the value of the raw material. In the United States in 1870, forest products in the rough were valued at about \$37,000,000; when manufactured the value was \$250,000,000. For the same year the iron product was valued at \$13,000,000; while the value of manufactured iron was \$500,000,000.

A quantity of iron ore sufficient to make a ton of iron, in the mine, would be worth only \$3 or \$4; but taken from the mine and manufactured into *pig iron*, it is worth \$25; made into *bar iron*, it is worth \$65; made into *steel*, it is worth \$300; made into *watch springs*, it is worth more than its weight of gold.

COMMERCE.

Commerce is the exchange of the products of one locality for those of another. Products sent from a place are *exports*, those brought into a place are *imports*.

Domestic commerce is that carried on between different parts of the same country; as, South Carolina exports rice and cotton to New England, and New England exports manufactured goods to South Carolina.

Foreign commerce is that carried on between different countries; as, the United States export wheat, corn, and cotton to England, and England exports iron and manufactured goods to the United States.

Sometimes a product is imported from one country, and then exported to another country; as, the United States import coffee from Brazil, and export the same coffee to Belgium, Germany, Mexico, etc.

TRANSPORTATION.—The carrying of persons or produce from one place to another is called transportation. Nearly all the transportation of foreign commerce, and much of that of domestic commerce, is carried on by means of boats on the oceans, lakes, rivers, and canals. Canals are artificial channels cut in the land and filled with water. The Erie canal is the most important canal in the United States; it connects the waters of the Niagara and Hudson rivers. There are numerous important canals in Europe.

There are more than 100,000 steam and sailing vessels engaged in the commerce of the world, besides many thousands of smaller boats; those on canals are moved by horse-power, some on rivers, by man power.

Some of the transportation of domestic commerce is carried on by means of domestic animals, but the main part is done by steam-power on railways.

The first railway was built of wooden rails, in about 1620, for the transportation of coal; the wooden rails were soon protected by strips of iron, then cast-iron rails were used, and finally, the rolled iron and steel rails used at the present time. Domestic animals were used as motive power on railways till 1804, when the first locomotive-engine was used. Since 1830 steam has been almost the only power used on railways.

Railways and locomotive engines were first made and used in England, but now the United States has as many miles of railway as all the rest of the world, and much better cars and engines than any other country.

In 1827 the United States had 3 miles of railway, in 1875 the United States have about 75,000 miles of railway in operation; England, France, Germany, Russia, etc., together, have about the same.

In the United States, the average cost of railways, equipped for business, is about \$55,000 per mile. The net profit of railways in the United States is about 5 per cent., a little more than in England. More than 35 per cent. of this profit is derived from the transportation of persons. Transportation by railway is more rapid than transportation by water, but not as cheap.

The conditions favorable to the growth of manufacturing countries are, an abundance of raw material, with but small cost for transportation, an abundance of cheap power and labor, with cheap and rapid transportation to the countries demanding the manufactured products.

The conditions favorable to the growth of commercial countries are, a surplus of natural or manufactured products, a demand for the products of other countries, and cheap transportation to other countries; or facilities for cheap and rapid transportation between countries which need each other's surplus products.

England, France, the United States, Germany, etc. are the principal manufacturing and commercial nations.

GOVERNMENT.

Man has a right to life, liberty, and the products of his industry. To protect these rights, and to promote the general welfare of mankind, governments became necessary.

Every government exercises three distinct functions:

1. The Legislative, or law-making function.
2. The Judicial, or law-applying function.
3. The Executive, or law-enforcing function.

A NATION.—The people sustaining and obeying a particular government constitute a *state* or *nation*.

There are different forms of government, depending on the character and intelligence of the people governed. The principal are,—the Republican, the Limited Monarchy, and the Absolute Monarchy.

REPUBLICAN GOVERNMENT.—In a republican form of government, the different functions are exercised by different bodies of men, the members of each chosen more or less directly by the people for a limited time.

The laws are made by a *Congress*, which consists of two houses, an *upper* and a *lower*; the upper house composed of a few members, chosen for a long term; the lower house, composed of a larger number of members, chosen for a shorter term. The laws are applied to particular cases by the *Judges* of the different courts, from the petty district court, to the supreme court of the nation. The laws are enforced by the *President* and his assistants. All the affairs of the government are carried on in accordance with a written compact or constitution, as interpreted by the judges of the supreme court.

The United States in North America, several nations in South America, and Switzerland in Europe, are republics.

Each state of the United States has a republican form of government, and in some instances, each county in the state, and each town in a county have the same form.

LIMITED MONARCHY.—In a limited monarchy, the *Monarch* or *Executive* holds his position for life, by virtue of his birth. The power of the monarch is limited by the courts, and by a legislative body, whose members are sometimes chosen by the people, but usually only a portion are chosen by the people, while the others are appointed by the monarch for life, or hold their positions by virtue of their birth. Limited monarchies are based on a constitution and fixed laws.

Great Britain and Germany are the most powerful and important limited monarchies. Practically there is no great difference between a limited monarchy and a republican form of government.

ABSOLUTE MONARCHY.—In an absolute monarchy the monarch holds his position for life, by virtue of his birth. The monarch not only executes the laws, but makes and applies them as well. Great numbers of persons aid the monarch in the exercise of the different functions, but he is supreme in each. Practically the will of the monarch is much limited by the will and intelligence of the people.

Russia and Turkey are the most powerful and liberal of the absolute monarchies.

In the absolute monarchies of Northern Africa and of Asia the monarch has almost absolute power over the life, liberty, and property of his subjects. These governments are often called *despotisms*.

The nations having the above forms of government include all the Indo-European Race and a portion of the Mongolian Race; the American, African and Malayian Races, are broken up into small tribes, with unstable governments of a monarchical form, which but poorly protect the rights of the people.

DIVISIONS OF MANKIND ON THE BASIS OF CULTURE.

On the basis of culture, (degree of intelligence, forms of government and religion, manner of living, etc.) mankind is divided into four classes; the Savage, Barbarous, Half-Civilized, and Civilized.

THE SAVAGE.—This class of mankind has a low degree of intelligence, speaks, but does not write the monosyllabic or agglutinative languages, and accepts the lowest forms of religion. The character of their food, clothing, and shelter depends on the climate in which they live. In the torrid zone, their food consists mainly of spontaneous vegetable products, and the bark and leaves of plants furnish materials for clothing and shelter. In the temperate zones, animals and fish are extensively used for food, and the skins of the animals furnish materials for clothing and shelter. In the frigid zone, they are dependent on animals, mainly, for food, clothing, and shelter, sometimes making houses of ice. The principal industries are hunting and fishing, sometimes a little agriculture by the women, who are treated as slaves. They have, in some cases, a few domestic animals; as, the horse, dog, reindeer, etc.; in general there is no division of labor, and but small accumulations of property. They have no knowledge of the metals, using implements of stone; they place a low estimate on the value of human life, and their governments are based on the principle that "might makes right."

This class includes the greater portion of the Malayian, African, and American Races, and that portion of the Mongolian Race living in the northern parts of America, Europe, and Asia.

THE BARBAROUS.—This class has a higher degree of intelligence than the Savage, using a better form of the same languages, making use of picture writing, etc. for purposes of history, and in some cases using phonetic characters. They live in cities, and understand the use of fire in working metals, carry agriculture, manufacturing, and architecture to a high degree of perfection. There are large accumulations of property, more or less division of labor, with such forms of religion as those of Egypt, of Brahmanism, and of Buddhism; governments despotic; learning mostly confined to the priests; slavery, caste, polygamy, etc. allowed. In this class are included such nations as the Ancient Assyrians, Egyptians, and Aryans; the Aztecs and Peruvians of America, and some nations in Africa and South-Western Asia.

HALF-CIVILIZED.—This class is a little in advance of the Barbarous, having more liberal forms of government, and higher forms of religion; as, those of Judaism and Zoroaster. Alphabets, and in some instances inflectional languages are used; learning is more widely disseminated among the common people, and there is a better knowledge of the useful metals than among the Barbarous class. The Ancient Jews and Phœnicians, the Chinese and Japanese are examples of this class.

CIVILIZED.—In civilized nations the inflectional languages are spoken and written; steel tools are in common use among the people, and all the industries, arts, and sciences are carried to a high degree of perfection. Universities, colleges, and common schools are supported by governments or individuals for the purpose of educating the masses of the people. Christianity, the highest form of religion; Republics and Limited Monarchies, the highest forms of government, prevail. Monogomy is legalized, and woman holds a high position.

Civilization has developed in successive steps, arising in Greece where a high degree of culture in art and literature was attained. Rome carried Christianity into all parts of Europe, and her code of laws is the basis of all modern law.

In about 1450 A.D. the art of printing gave a new impetus to civilization, and transferred the leadership in progress from the Latin and Greek nations to the German in Central Europe.

The successful application of steam power to machinery in about 1770 marks another step in the progress of civilization.

The European branches of the Aryan family include all the civilized nations.

Asia is called the cradle of the human family, but Europe is the cradle of civilization. The descendants of Europeans in America now rival the mother countries in their contributions to the progress of mankind.

In connection with this work the following books can be used with profit:

“History of Culture,” by Hittell.

“Ten Great Religions,” by James F. Clark.

“Brace on the Races.”

“Chambers’ Encyclopedia.”

“Guyot’s Physical Geography.

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